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UDC 534.222

Doubling Frequency of Sound Wave in Nonlinear Layer

907J0132B Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 36 No 4, Jul-Aug 90 pp 708-711

[V.Ye Nazarov, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] A method of determining the nonlinearity factor γ_0 in the one-dimensional equation $u_{tt} - c_0^2 u_{xx} = 2\gamma_0 c_0^2 u_x u_{xx}$ (u - displacement of particles in such a wave, c_0 - speed of longitudinal waves in given medium) for longitudinal waves propagating through a solid material is described, this is based on a theory of elasticity involving five constants. The method involves measurement of the second harmonic generated in a plane-parallel plate of that material upon normal incidence of plane sound wave. This plate is immersed in some fluid medium and is equal to an integral number of half-wavelengths so it is acoustically matched to the medium, not only at the frequency of the incident wave, but also at the harmonic frequencies. Harmonics will be generated in a plate of a nonlinear material which will emit both forward and backward into the ambient fluid. Inasmuch as such a plate at resonance does reflect the incident wave significantly, but transmits it, only the backward second harmonic it generates and emits will travel through the ambient medium to be picked up by a receiver. The nonlinearity factor characterizing the plate material can then be found by solving that equation by the perturbation method, the two integration constants being determined from the boundary conditions for $(\sigma/v)^2$ equal to $-\rho c$ at the front interface and to $+\rho c$ at the back interface (σ - stress, v - velocity, ρ - density of ambient medium, c - speed of sound in ambient medium). The solution yields the amplitude of the second harmonic, which needs to be compared with that of the incident wave. Numerical estimates have been made on this basis for a steel plate in water. The author thanks L.A. Ostrovskiy for interest and valuable comments. References 5.

UDC 53.01+551.510:534.222.1

Use of Acoustic Sounding for Determination of Aerosol Parameters

907J0132C Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 36 No 4, Jul-Aug 90 pp 712-717

[Article by V.Ye. Nemtsov, Scientific Research Institute of Radiophysics]

[Abstract] Acoustic sounding is considered for aerosol measurements, taking into account the three mechanisms of sound dissipation in such a medium: evaporation and condensation of liquid particles, heat transfer from gas to liquid, and Stokes friction. The theory of this method is furthermore refined by treating the aerosol as a polydisperse system and by including mass transfer. Assuming that the specific volume of the dispersed liquid phase is much lower than unity, and the density of their vapor is much lower than the density of air, considering also that the frequency of the sound wave is much lower than the critical one equal to the kinematic viscosity divided by the mean diameter of aerosol particles, two equations of motion for a spherical liquid particle and the vapor-gas mixture respectively are supplemented with the two equations of continuity for the gas and for the vapor respectively. The conventional equation of particle growth as a result of condensation following quasi-steady diffusion, the mass rate of particle growth being determined here by the saturation density of vapor dependent on the surface temperature as well as by the diffusion coefficient and the particle diameter, is also added along with two equations representing the law of energy conservation for liquid particles and the vapor-gas mixture respectively and the equation of state for the gas-vapor mixture in the ideal gas approximation. All these equations together form a closed system from which a dispersion equation for the sound describing the dependence of its wave number on its frequency, with c_s (speed of sound in the vapor-gas mixture, in the adiabatic approximation at infinitely high frequency of sound) as principal parameter is derived. When heat transfer during condensation and evaporation is ignored, this dispersion equation yields formulas for calculating absorption and dispersion of sound in a polydisperse aerosol not in the process of phase transitions. On this basis the aerosol size distribution parameters can then be determined, namely mean size and size dispersion of aerosol particles, also their concentration. Most expedient for this method of aerosol measurements is use of sound pulse, inasmuch as its leading edge moves at the speed c_s faster than trailing edge and the difference between their speeds is proportional to the specific volume of the dispersed liquid aerosol phase while the attenuation of the leading sound pulse is proportional to the concentration of aerosol particles. It may be further necessary, and it is possible on the basis of these measurements and extended analysis, to determine the sound dispersion characteristics, namely decrease of phase velocity and increase of attenuation, over a wide frequency range. References 16.

UDC 624.07:534.1

Solitary Wave in Uniformly Curved Thin Beam

907J0132D Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 36 No 4, Jul-Aug 90 pp 730-732

[Article by S.A. Rybak and Yu.I. Skrynnikov, Institute of Acoustics imeni N.N. Andreyev, USSR Academy of Sciences]

[Abstract] Propagation of longitudinal strain waves through a uniformly curved thin rod is analyzed on the basis of the corresponding nonlinear Klein-Gordon equation, a nonlinear equation for a longitudinal strain

wave in a straight beam having already been derived and its steady-state solutions found by balancing hydrodynamical quadratic nonlinearity and acoustical quadratic dispersion. Its steady-state solution is sought in the form $u = u(\eta)$ (u - longitudinal strain, $\eta = x - Vt$) describing a solitary wave which propagates at a constant velocity V, finite for all values of η and vanishing together with its derivative $v_\eta = du/dt$ as $\eta \rightarrow +/-\infty$. This solution, $v_\eta^2 / 2 - (v^2 - v^3) / 2R^2(1 - V^2/c_0)(3v - 2)^2 = 0$, represents the law of energy conservation for a particle of unit mass moving in the potential field $U(v) = -(v^2 - v^3) / 2R^2(1 - V^2c_0^2)(3v - 2)^2$. The profile of the sought solitary wave is determined accordingly. Its description, in the implicit form $\eta/R(1 - V^2 / c_0^2)^{1/2} = f(v)$, reveals two ranges where $0 < v > \frac{2}{3}$ ($|\xi| < \xi_0$) and $\frac{2}{3} < v < 1$ ($|\xi| < \xi_0$) respectively and a singularity of the same kind in the vicinity of each wavefront attributable to the higher-order derivative in the nonlinear term of the Klein-Gordon equation. A solitary wave exists only in a nondissipative medium (energy dissipation by any mechanism would lead to its decay), where both its amplitude A and width Δ depend on its velocity V as those of a Korteweg-deVries soliton depend on its velocity. The authors thank Yu.A. Stepanyants for discussion. Figures 2; references 6.

Emission of Acoustic Waves and Formation of Hot Jet During Motion of High-Speed Source in Medium With Relativistic Equation of State

907J0133D Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 98 No 2, Aug 90 pp 377-386

[Article by V.N. Pavlov and O.A. Kharin, Moscow State University imeni M.V. Lomonosov]

[Abstract] The passage of a relativistic high-energy particle, such as a giga-electron-volt proton through a nuclear medium at a speed approaching the speed of light, is considered, along with the attendant energy transfer to such a medium whose equation of state admits the possibility of attendant perturbations also propagating at a speed comparable with the speed of light. The equations of hydrodynamics extending the Euler equation to a relativistic medium with a relativistic source are derived from the laws of energy and momentum conservation in such a medium. These laws were formulated in the notation of special relativity as four-dimensional divergence of the system's energy-and-momentum tensor with only friction of the moving particle against the medium assumed to contribute to dissipation of its energy and momentum. Following this description of the moving energy and momentum source, the structure of its acoustic field is described in a reference system which moves with the particle. An analysis of sound emission yields the condition for phasing of sound waves when they propagate at a speed comparable with the speed of light while a particle moves through the medium at a comparable uniform "supersonic" speed. Next, temperature changes are evaluated in the medium, which resulting interaction with a moving particle, the medium assumed to be an ideal Fermi liquid at a temperature far below the Fermi energy level so that small changes of its temperature squared are proportional to small changes of density and pressure. Thus, considering that in this case isothermal compressibility and adiabatic compressibility coincide, the equation of the acoustic field is converted into a closed equation of the temperature field with an analogous implied continuity. The solution to this equation, obtained with the aid of Fourier transformation, indicates that uniform "supersonic" motion of a relativistic particle generates not only Mach shock waves in the medium but also a hot jet around which the temperature of the medium remains unchanged. The temperature distribution in this jet is determined principally by the thermal conductivity of the medium. Its evaluation must take into account "diffusion" of the jet owing to heat conduction. It has been evaluated numerically for a 1 GeV relativistic particle rushing in. It is possible, moreover, to determine the temperature of the medium at which a phase transition with "boiling" and "bursting" of nuclei will occur in the wake behind the particle. Figures 4; references 17.

Steady Vortex Structures in Ideal Fluid

907J0133E Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 98 No 2, Aug 90 pp 532-541

[Article by O.V. Kaptsov, Computation Center, Siberian Department, USSR Academy of Sciences]

[Abstract] Steady axisymmetric three-dimensional flow of an inviscid fluid, and thus ideal inviscid fluid, is analyzed according to classical theory of hydrodynamics. Group classification of the nonlinear equation for the flow function ψ (Graede-Shafranov equation in plasma physics) $\psi_{rr} + \psi_{zz} - \psi_r/r = r^2G(\psi) + F(\psi)$ (at least one of the two functions G,F nonlinear and G not equal zero) yields the Liouville equation, which admits an infinite-dimensional group and is reducible to the Laplace equation with an ample number of exact solutions. That nonlinear equation is not likely to be linearizable, inasmuch as only for $G = A\psi^n$ and $F = B\psi^{(2n+1)/2}$ or $G = Ae^{\psi}$ and $F = Be^{2\psi/3}$ does it admit "additional" infinitesimal operators on the flow function. It is solved by separation of variables, possible only when $G = Ar^2\psi$ and $F = B\psi(\log\psi)$. Its solution yields new classes of steady flow structures, toroidal and periodic vortical ones among them. New structures are also revealed by analogous solution of the equation $\psi_{zz} + \psi_{yy} = zG + F$ for the function ψ, which describes steady two-dimensional flow of a stratified fluid. Figures 7; references 11.

Anomalies in Reflection and Absorption of Radiation in Pulsed Laser Beams of Finite Duration by Periodically Uneven Metal Surfaces

907J0125A Moscow ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 60 No 6, Jun 90 pp 73-78

[Article by A.N. Dolgina, A.A. Kovalev, P.S. Kondratenko, and V.M. Finkelberg, All-Union Scientific Research Institute of Optical Physical Measurements (Scientific-Industrial Association)]

[Abstract] Reflection and absorption of radiation in a laser beam by a periodically uneven metal surface with attendant formation of surface electromagnetic waves are analyzed, specifically considering a pulsed laser beam of finite dimensions and finite duration on a metal surface with a sinusoidal profile. Such a laser beam is treated as a packet of waves within a narrow $\Omega = \omega + \Delta\omega$ frequency band with wave vectors within a narrow range $K = k + \Delta k$; ω and k being the frequency and the wave vector of the carrier. The electric field of this laser beam is represented as in the form $E(r,t) = A(r,t)\, e^{(ikr - i\Delta\omega)}$ with an amplitude A(r,t) slowly varying in space and time. The profile of the metal surface is described by the equation $z = z^* = b \sin(gr)$ with an amplitude b much smaller than the wavelength of incident radiation (z - coordinate along the normal to the plane of incidence, g - vector of reciprocal lattice). Resonance diffraction of a plane monochromatic electromagnetic wave in the incident radiation beam and resonance excitation generating a surface electromagnetic wave are considered, assuming that the latter appears in the first diffraction order. The amplitude of this wave and the amplitude of the specularly reflected wave in the zeroth diffraction order are calculated, in the impedance approximation, on the basis of analytical expressions relating the partial amplitudes of plane waves in the diffracted radiation beam. In subsequent calculations the radius R of the radiation beam is normalized to the mean free path L for a surface electromagnetic wave and the duration of its pulse is normalized to the mean life of such a wave T. First is considered a radiation beam with an infinitely large radius incident in a pulse with a square envelope of a duration varied up to 4T. The intensity of the reflected wave is, in this case, found to peak at the end of the incident pulse and then to jump to another peak later, this peak being lower or higher than the earlier one depending on whether the duration of the incident pulse was $t < T$ or $> T$. Increasing the amplitude of the surface profile and thus correspondingly decreasing the mean free path L is found to cause the second peak intensity of the reflected wave, when reached after a sufficiently long time, to exceed the intensity of the incident one. Next is considered a Gaussian radiation beam with a radius $R = 2L$ incident in a parabolic pulse of duration $t = 2T$. In this case, too, calculations reveal distortions of the reflected wave, also a dependence of the reflection coefficient at the surface on the distance from the radiation spot as well as of both reflection and absorption coefficients on the radius of the incident radiation beam and on the duration of its pulse. Figures 4; references 12.

UDC 621.373.826.038.825.2

New Acentric Low-Threshold Laser Crystal $LaBGeO_5$: Nd^{3+}

907J0128A Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 17 No 8, Aug 90 pp 957-958

[Article by A.A. Kaminskiy, B.V. Mill, and A.V. Butashin, Institute of Crystallography imeni A.V. Shubnikov, USSR Academy of Sciences, Moscow]

[Abstract] A new laser material has been produced by the Czochralski method, an acentric low-threshold $LaBGeO_5$:Nd^{3+} crystal of the C_3^2-P3 space group with a trigonal unit cell in which Nd ions replacing La ions form one kind of activator and centers with C_1 symmetry and the coordination number nine. Its crystallographical and other physical as well as chemical and spectral characteristics are already known, the lifetime of its luminescence in the metastable $^4F_{3/2}$ state being 270 - 290 μs at 300 K temperature and with low activator concentration. Several lasers with cylindrical crystals 6 mm in diameter and 40 mm long containing 2 atom.% Nd were and built and tested for an experimental performance evaluation. They were optically pumped with radiation pulses of approximately 70 μs duration from ISP-250 flash lamps inside elliptical luminaires. A confocal high-Q optical cavity was formed by spherical mirrors with a 600 mm radius and with a dielectric coating which raised the reflection coefficient above 0.99 for the laser radiation. Tests were performed at liquid-nitrogen temperature inside a tubular glass cryostat, emission occurring along two channels: $^4F_{3/2} \rightarrow {}^4I_{11/2}$ and $^4F_{3/2} \rightarrow {}^4I_{13/2}$. The authors thank K. Kurbanov and L.A. Polyakov for assisting in the spectroscopic measurements. Figures 3; references 2.

UDC 621.378.325

New Methods of Passive Q-Switching of Erbium-Glass Laser

907J0128B Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 17 No 8, Aug 90 p 959

[Article by B.I. Denker, G.V. Maksimova, V.V. Osiko, S.Ye. Sverchkov, and Yu.Ye. Sverchkov, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] Two new methods of passive Q-switching of erbium-glass lasers are proposed, erbium glasses being characterized by a purely 3-level emission scheme with the luminescence spectrum within the 1.5 μm wave band almost exactly duplicating the absorption spectrum. Both methods were successfully tested on an active element made of (Nd,Er,Yb) glass 6.3 mm in diameter and 100 mm long inside a diffusely reflecting luminaire. The optical cavity between a lens and a concave high-reflectance mirror had a total power of about 0.5 D, with that mirror in the proper position, and remained stable despite thermal distortions of the active medium. The first method involves use of an approximate 0.1 mm thin

shutter made of the same glass as the active medium but containing only Er ions, about 7 x 10^{20} cm^{-3}, and having a high initial transmittance. Best results were obtained by placing such a shutter with 82 percent initial transmittance in the constriction of the laser beam at the Brewster angle to it. Even under suboptimum conditions and despite optical nonhomogeneity of the active medium, the laser emitted TEM_{00} mode pulses of 6 mJ energy and 300 ns duration at the 50 percent level with repetition rates up to 0.5 Hz. As losses in the TEM_{00} mode became excessive (at higher pulse repetition rates, for example, depolarization of the radiation occurring in the thermally stressed active medium), emission of such pulses changed to emission of multimode pulses of energy as high as about 130 J (equivalent to 27 percent of the free-emission pulse energy) and still higher up to about 250 mJ destroying the shutter. The second method of passive Q-switching involves increasing the reflectance of the active medium by pumping it with radiation from a Q-switched ruby laser. The best results by this method were obtained with the active medium in an optical cavity between a plane high-reflectance mirror, a plate of single-crystal germanium, and a 60 percent reflectance exit mirror. The free-emission threshold here was a pump pulse energy of 157 J. When pumped with pulses of 177 J energy, the laser emitted giant pulses of 150 mJ energy and about 100 ns duration. Such pulses destroyed the germanium plate, however, so that this method of Q-switching is good for one-shot laser operation only. Figures 1, references 4.

UDC 621.373.826.038.825

Producing Wide-Aperture Frequency-Tunable Ultraviolet Radiation

907J0128C Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 17 No 8, Aug 90 pp 971-974

[Article by I.A. Begishev, A.A. Gulamov, Ye.A. Yerofeyev, Sh.R. Kamalov, T. Usmanov, and A.D. Khadzhayev, Institute of Electronics imeni U.A. Arifov, UzSSR Academy of Sciences, Tashkent]

[Abstract] Continuous frequency tuning of narrow-band ultraviolet radiation pulses by mixing second and fourth harmonics of laser radiation with parametric waves in a nonlinear crystal was studied in an experiment involving a wide-aperture glass (phosphate):Nd laser and a KDP mixer crystal. Subnanosecond gigawatt pulses of up to 0.5 ns duration and up to 16 J energy were emitted by that laser in a fifth-degree hypergaussian beam with diffractional divergence and a 16 mm radius to the 50 percent peak intensity level. Pulses of its second harmonic were passed through a telescope for compression and from here to two KDP crystals which they excited into superluminescent parametric emission of light. The efficiency of conversion into infrared parametric waves depended on the power density of second-harmonic radiation, peaking at a 6 GW/cm^2 power density of that radiation to a 48 percent maximum with a 6x-magnification cylindrical telescope and to a 70 percent maximum with a 2.5x-magnification spherical telescope. The nondegenerate emission of infrared waves was tunable over the 0.83 - 1.35 μm range. These waves and residual second-harmonic radiation merged in a KDP mixer crystal, a 17.5 mm thick plate 50 mm square cut for type-II synchronism, where one of the waves, b mixing with that radiation, converted it into ultravic radiation. The efficiency of this conversion did ot exceed 13 percent. The experiment was performed with a GLS-22 glass (phosphate):Nd master laser oscillator emitting one longitudinal mode and one transverse mode of radiation within a 3 pm wide spectral line in pulses of 27 ns duration at the 50 percent level. The master laser was followed by a two-pass GLS-22 laser amplifier feeding a Pockels cell, a plane mirror behind the amplifier transmitting 10 percent of the laser radiation to a discharger which triggered the Pockels cell and reflecting 90 percent of the laser radiation onto another plane mirror which in turn reflected it into the Pockels cell directly. The latter was followed by a three-pass GLS-22 laser amplifier feeding a second Pockels cell. This one was followed by a spatial filter including a "soft" diaphragm between two biconvex lenses, the latter by two more GLS-22 laser amplifier stages, and the second amplifier stage by a semitransparent plane mirror splitting the filtered and amplified laser radiation into two channels. This mirror reflected the radiation into one channel directly via a 45° oblique plane mirror and transmitted into another channel via an optical delay line formed by two 45° oblique plane mirrors an appropriate distance apart, the reflectance-to-transmittance ratio being controllable over to 40:60 - 60:40 range. The channel behind the delay line consisted of three GLS-22 laser amplifier stages, each preceded by a vacuumized spatial filter, and the third stage followed by a KDP frequency-doubler crystal. The other channel had an analogous structure up to and including a KDP mixer crystal, but the latter was followed by a light filter, a biconcave telescope lens, two more KDP mixer crystals, and a pair of oblique plane mirrors with a another biconcave telescope lens plus a biconvex lens between them. Both channels fed another KDP mixer crystal between KDP prisms and an exit prism. Thus, ultraviolet radiation was produced within the 352 nm band, tunable by synchronous rotation of this last KDP crystal and the two others between the two telescopes in the channel without delay line. In another experiment similarly tunable fifth-harmonic radiation emission within the 215 nm band was produced by mixing fourth-harmonic radiation from a glass (phosphate):Nd laser

with parametric light waves in an ADP crystal, the latter being cooled to -70°C for ensuring 90° phase synchronism or held at room temperature ensuring 90° phase synchronism with the aid of the idle (long-wave) parametric component of light, and by insertion of another KDP mixer crystal cut for type-I synchronism between the KDP prism and last KDP mixer crystal so as to prevent two-photon absorption in the that prism. Figures 3; references 8.

Measurements of Width of Emission Line of GaInAsSb Long-Wave Injection Lasers

907J0134A Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 16 No 14, 26 Jul 90 pp 66-70

[Article by A.G. Avetisov, A.N. Baranov, A.N. Imenkov, A.I. Nadezhinskiy, A.N. Khusnutdinov, and Yu.P. Yakovlev, Institute of Engineering Physics imeni A.F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] The width of emission lines of two GaInAsSb long-wave lasers was measured, a D307/184 buried-channel diode with a falciform active region and a C61-11 or C16-8 mesa diode, each emitting only a longitudinal mode at pumping levels 10-50 percent above the threshold. The emitter region of the two laser diodes contained $x \simeq 0.34$ Al and $x \simeq 0.5$ Al respectively. An absorption line of CO_2 gas, namely the 1.97 μm line of its 00°0 - 20°1 band, was the discriminator, used as amplitude-frequency for this measurement. Each laser was placed inside a cryostat with a temperature regulator so that the temperature could be set and held at any point within the 80 - 320 K range, and could be held accurately within 0.001 K. Each laser was pumped electrically with square current pulses of 10 ms duration at 10 Hz and higher repetition rates. The photodetector was a GaInAsSb diode with a 1.3 - 2.4 μm wide sensitivity zone and a 0.6 quantum efficiency. Frequency noise was recorded in two ways, by recording the segment of the photodetector signal along the slope of the laser absorption line around the maximum of the $gdk/\delta v$ derivative (k - absorption coefficient, ν - radiation frequency) and by measuring the integral characteristic of laser frequency noise in terms of dispersion within the preamplifier passband. The latter method involved use of a low-pass filter and an oscillograph. Calculations based on the first method yielded a predominantly "white" noise within the 200 kHz - 2 MHz range, while differentiation of the envelope of the absorption revealed a modulation of the frequency noise by the $(\delta k/\delta) e^{k(\nu)}$ function. The results pertaining to both GaInAsSb lasers indicate that the width of their emission line can change by more than an order of magnitude, decreasing as either their emission power is raised or their temperature is lowered, which is consistent with the Shavlov-Townes relation. Figures 2; tables 1; references 6.

Contactless Electrooptical Measurement of Ultrashort Electric Signals With Picosecond Semiconductor Laser

907J0134B Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 16 No 14, 26 Jul 90 pp 84-89

[Article by V.L. Karaganov, Ye.L. Portnoy, N.M. Sinyavskiy, A.P. Stalnenis, N.M. Stelmakh, and A.V. Chelnokov]

[Abstract] A picosecond semiconductor laser with a saturable absorber produced by deep implantation of heavy ions was experimentally used as a generator of strobing pulses in an electrooptical oscillograph for contactless measurement of ultrashort electric signals. A major problem with such measurements is the instability of the laser pulse emission timing relative to the electric pumping pulse and the resulting "jitter" effect. The optical part of the measuring apparatus included an AlGaAs laser, a roof prism preceded by a collimating lens and followed by an optical delay line, a plane mirror, a polarizing prism, a converging lens, an electrooptic $LiNbO_3$ crystal on the microwave device generating ultrashort electric pulses, a collimating lens, a Pockels cell, a polarized beam-splitter prism, and two photodiodes feeding a differential amplifier. The electrical part of the measuring apparatus included a master oscillator pumping the laser through a pulse shaper and also feeding a modulator. A 1 kHz modulating oscillator fed the same modulator, a shaper of voltage-drop pulses with 30-40 ns rise time from 0.1 to 0.9 of a 0.4 V amplitude fed by the modulator through an electrodynamic delay line, a synchronous detector behind the differential amplifier, and an oscillograph for recording the detector output signals. The time instability of emission was measured by having two identical lasers pumped electrically in parallel by pulses from the same oscillator through a 30-40 ns delay line. The parallel beams emitted by the two lasers were, after passage through a microobjective lens, combined by an opaque plane mirror and a semitransparent plane oriented both at a 45° angle to the beams and together sent to an image converter. Measurements were made by scanning that image converter with electric pulses from the same oscillator through a 3 ns delay line. A single scan of the image converter yielded the time interval between emission pulses of the two lasers. The "jitter" was found to be 30 ps long and 3 ps long during emission of single spikes by the lasers when pumped with 5 ns pulses and with 0.5 ns pulses respectively. Figures 3; references 7.

UDC 535.373.2

Process of Energy Transfer From Excited States of Active Particles in Laser Materials

917J0001A Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1442-1449

[Article by M. A. Noginov, V. A. Smirnov, and I. A. Shcherbakov, Institute of General Physics, USSR Academy of Sciences]

[Abstract] A brief review is given of reports presented at a conference on tunable lasers held in Irkutsk in 1989 concerning problems of the interaction of excited ions and photostimulated absorption in solid-state lasers. Topics covered include the use of an yttrium-scandium-gallium garnet crystal activated with chromium and erbium ions which, when strongly excited, yields a population inversion which varies nonlinearly with the pumping power, with lasing wavelength variable by changing the spectral composition of the pumping radiation, its intensity and the shape and length of the exciting light pulse. Other topics covered were—1) the interaction of excited Er^{3+} ions in fluoride crystals; 2) quantitative description of the processes of electron excitation energy transfer and interactions of excited Er^{3+} ions; 3) energy transfer in double activated media lasing at two wavelengths and the associated attenuation of luminescence; 4) the interaction of activator ions with the external electromagnetic pumping field; 5) mechanisms of photostimulated absorption in rare-earth scandium garnet crystals with chromium; 6) the state of spectroscopy and the generation properties of alexandrite crystals; 7) absorption of $^4T_2Cr^{3+}$ in $KZnF_3$ crystals to determine its influence on the basic characteristics of a $KZnF_3:Cr^{3+}$ laser with lamp pumping; and 8) $YAlO_3:V^{4+}$ crystals as potential active media for visible light tunable lasers. Figures 4; References 16: 7 Russian, 9 Western.

UDC 621.373.826

Generation Characteristics of "Malsan-200" Series Tunable Lasers

917J0001B Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1450-1455

[Article by T. T. Basiyev, P. G. Zverev, F. V. Karpushko, V. A. Konyushkin, S. M. Kulashchik, S. B. Mirov, V. P. Morozov, V. S. Motkin, A. G. Papashvili, N. A. Saskevich, G. V. Sinitsyn, and V. V. Fedorov, Institute of General Physics, USSR Academy of Sciences; Institute of Physics, Belorussian Academy of Sciences]

[Abstract] A study is made on the physical details of the excitation of lasing in the Malsan-201 laser. Optimization of the spectral and power characteristics, and means and methods of modernization are discussed. These lasers, based on the use of crystals with color centers, operate at room temperature and are designed to produce powerful, smoothly tunable radiation in the near IR area. The Malsan-200 generates nanosecond pulses which can be tuned from 0.84 to 1.25 μm with effective transformation of pumping radiation up to 20 percent with a generated line width of less than 0.3 cm^{-1}. The studies performed resulted in modification of the optical system and creation of a more compact single-channel laser with interchangeable optics and active elements, the Malsan-203, which has the same operating parameters. Figures 3; References 28: 24 Russian, 4 Western.

UDC 621.373

Spectral-Power Parameters of Color-Center Lasers With Broadband Excitation

917J0001C Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1456-1462

[Article by F. V. Karpushko, G. V. Sinitsyn, V. A. Saskevich, V. P. Morozov, and A. S. Yasyukevich, Institute of Physics imeni B. I. Stepanov, Belorussian Academy of Sciences]

[Abstract] This review of the Soviet and Western literature discusses the creation and investigation of lasers based on crystals with color centers and flash-lamp excitation. The results of the works discussed indicate that color-center crystals in most cases use the energy of the exciting radiation quite inefficiently, since a large fraction of the energy in the UV and blue spectral areas is absorbed in filters. The use of luminescent transformers which reradiate energy from the UV in the visible and near IR areas can improve efficiency. Major problems remaining in this area include the search for new methods of production of crystals and various matrix centers with good light and heat stability in combination with good spectroscopic parameters, which define their lasing capabilities. Figures 3; References 24: 18 Russian, 6 Western.

UDC 548.0:535.34

Quasicontinuous Tunable $Al_2O_3:Ti^{3+}$ Flash Lamp Pumped Laser

917J0001D Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1463-1466

[Article by B. K. Sevast'yanov, V. P. Orekhova, V. V. Nabatov, L. S. Starostina, A. P. Chirkin, K. P. Chirkina, Yu. N. Mart'shchev, A. Yu. Toporov, A. L. Bratus', A. A. Krivolapov, M. Yu. Sharonov, S. F. Lebedeva, and G. S. Leonov, Institute of Crystallography imeni A. V. Shubnikov, USSR Academy of Sciences; "Zenit" Scientific-Production Association]

[Abstract] A quasicontinuous laser with flash lamp pumping based on $Al_2O_3:Ti^{3+}$ crystals with radiated pulse length up to 600 μs is described. The laser requires flash lamps which generate light pulses at least 500 μs in length with a steep leading edge 10-20 μs in length. Radiators with 2, 4 and 6 lamps were tested, with diffuse or specular reflectors with near-elliptical cross section. The use of interference-polarization filters as light dispersing elements significantly improved the characteristics of the laser. A single-stage filter was able to constrict the line width to 3 - 4 nm while achieving a tuning range of 716 to 812 nm, the laser energy representing up to 90 percent of energy E_0 in the resonator. The use of a two-stage filter further narrowed the generated line to 1

nm while expanding the tuning range to 698 to 880 nm. The laser energy with this filter represented 20 - 50 percent of E_0. Figures 3; References 12.

UDC 535:621.373.8;535:621.375.8

Crystals With Color Centers for Laser Equipment

917J0001E Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1467-1475

[Article by V. I. Baryshnikov, V. A. Grigorov, B. D. Lobanov, Ye. F. Martynovich, E. E. Penzina, V. M. Khulugurov, and V. A. Chepurnoy, Scientific Research Institute of Applied Physics, Irktusk State University]

[Abstract] Some results are presented from studies performed at Irkutsk University on the creation of crystals with color centers for lasers operating at room temperature, including lithium fluoride, alkali halide crystals with Z centers, sapphire with color centers and diamond crystals. The following was concluded—LiF crystals contain two mobile defects - V_a^+ and F_2^+ centers which play a decisive role in the formation of color centers. Alkali halide crystals containing Z-type color centers are promising for the development of effective two-micron laser gates. Diamond crystals bombarded with accelerated electrons, protons or fast neutrons can be used to produce laser media with absorption factors of 5 cm^{-1} and more. Figures 4; References 44: 33 Russian, 11 Western.

UDC 621.378.3

Polymer Lasers: Photophysics of Active Medium, Optical Systems and Lasing Parameters

917J0001F Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1476-1483

[Article by V. I. Bezrodnyy, M. V. Bondar, O. V. Przhonskaya, and Ye. A. Tikhonov, Institute of Physics, Ukrainian Academy of Sciences]

[Abstract] Results are presented from studies and development of polymer lasers at the authors' institute, including the manufacturing process and photophysical properties of the active media, optical systems and lasing characteristics, and generation of light with excimer pumping at 308 nm. The scientific principles and technology have been developed for the use of an elastic polymer material, polyurethane acrylate, as the matrix for visible and near IR band polymer lasers. Further study is needed in the area of modifying optical systems of the lasers, decreasing the significance of heating of the optics, increasing the operating life and improving output parameters. The possibility is shown as using a polymer matrix to pump an XeCl laser. Further studies are needed to improve the optical quality of the polymer lasers and expand the range of generation in polymer lasers pumped by excimer lasers. Figures 3; References 15: Russian.

UDC 535:621.373.8;535:621.375.8

Low-Inertia Broadband UV Pumping of Laser Crystals

917J0001G Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1484-1486

[Article by V. I. Bar'shnikov, S. V. Dorokhov, T. A. Kolesnikova, Ye. F. Martynovich, and L. I. Shchepina, Scientific Research Institute of Applied Physics, Irkutsk State University]

[Abstract] A high-power laser system has been developed based on noninertial control of gas discharge parameters containing a radiation-resistant fluoride-oxide single crystal laser. In the pumping system of this laser a special discharge chamber and miniature electron accelerator make up a single miniature coaxial structure. The laser crystal is located in the discharge chamber and is surrounded by a gas discharge plasma. The generator and accelerator are synchronized with nanosecond accuracy, sharply increasing the light output of pumping by allowing preionization of the gas volume by the electron beam and transfer to the discharge of the pulse energy of a powerful high-voltage nanosecond generator. Figures 2; References 2: Russian.

UDC 621.373.826

Pulse Generation Dynamics in Dye Lasers With Nonsteady Synchronous Pumping

917J0001H Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1487-1493

[Article by G. I. Onishchukov, S. D. Ryabko, and A. A. Fomichev, Moscow Institute of Physics, Technology]

[Abstract] A study is made on the lasing of dye lasers with nonsteady synchronous pumping by the second harmonic of continuous YAG:Nd lasers operating in double Q modulation mode. Studies were performed experimentally by numerical modeling using an equation system extended to cover the case of hybrid mode synchronization. Hybrid synchronization with passive dye lasing, pumping by trains of short compressed pulses or a combination of these methods can produce pulses approximately 1 ps in length with an energy two to three orders of magnitude higher than in the steady mode. Figures 3; References 15: 8 Russian, 7 Western.

UDC 621.373.8

Control of Lasing Characteristics of $Al_2O_3:Ti^{3+}$ Lasers

917J0001I Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1494-1499

[Article by P. N. Nazarenko, N. V. Okladnikov, and G. A. Skripko, Interbranch Institute of Continuing Education, Belorussian Polytechnical Institute]

[Abstract] A study is made of the possibility of optimizing the energy characteristics while stabilizing the time and spectral characteristics of $Al_2O_3:Ti^{3+}$ lasers. Results are presented from experimental studies on the control of the generation characteristics of a laser with high pulse repetition frequency. The studies demonstrate the high reliability of the laser and the possibility of controlling its generation parameters over a broad range. The use of resonator elements with variable coupling with the external space allow favorable combinations of tuning range, efficiency, line width and pulse length to be achieved. Tuning over 680 - 980 nm with generated line width 3 nm, stabilization of energy, spectral and time characteristics, the combination of 10^4 - 10^5 Hz pulse repetition frequency and controlled wavelength and delay time between pumping and lasing pulses can significantly expand the area of application of tunable lasers. Figures 3; References 6: 5 Russian, 1 Western.

UDC 621.373.826.038.825.2

Lasing at 1.34 - 1.6 μm Wavelength by $Y_3Al_5O_{12}:Cr^{4+}$ Laser

917J0001J Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1500-1506

[Article by N. I. Borodin, V. A. Zhitnyuk, A. G. Okhrimchuk, and A. V. Shestakov]

[Abstract] An experimental study was performed on the characteristics of a YAG:Cr^{4+} laser in various modes. A theoretical description is presented on the energy parameters of this type of laser and studies are performed to determine the potential capabilities of the material for tunable IR-band lasers. The basic parameters of the material, lasing at 1.35 - 1.55 μm, are determined. It is found that the efficiency of this type of laser can reach 20 - 25 percent with optimized excitation conditions. Figures 5; References 4: Russian.

UDC 621.373.826

Beryllium Aluminates Activated by Titanium and Chromium Ions as Tunable Laser Active Media

917J0001K Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1507-1511

[Article by A. I. Alimpiyev, Ye. V. Pestryakov, V. V. Petrov, and V. I. Trunov, Institute of Heat Physics, Siberian Division, USSR Academy of Sciences]

[Abstract] Results are presented from studies of the optical, luminescent and lasing properties of $BeAl_6O_{10}$ and $BeAl_2O_4$ activated by ions of trivalent chromium and titanium as active media for tunable near IR-band lasers. It is found that the substances can be successfully used in lasers with continuous excitation using kryptron and argon ionic lasers as the pumping sources. Beryllium aluminates can be activated not only by iron-group ions, but also by ions of the platinum and palladium groups and posttransition elements. Figures 5; References 12: 6 Russian, 6 Western.

UDC 621.378.535

Active Media for Tunable Lasers Based on Chromium-Containing Fluorides

917J0001L Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1512-1519

[Article by M. V. Mityagin, S. I. Nikitin, N. I. Silkin, A. P. Shkadarevich, and Sh. I. Yagudin, Kazan State University]

[Abstract] Results are presented from studies of the spectroscopic characteristics and laser properties with selective and flash lamp pumping of crystals of $KZnF_3$, $SrAlF_5$ and $LiCaAlF_6$ activated by Cr^{3+} ions. The results of the studies demonstrate that $KZnF_3:Cr^{3+}$ crystals are promising for solid-state tunable lasers with flash-lamp pumping operating at 785 - 870 nm, comparable in their efficiency to alexandrite lasers. Laser experiments with $LiCaAlF_6:Cr^{3+}$ crystals are preliminary. Significant improvement in lasing characteristics can be expected if an increase in the concentration of Cr^{3+} ions, an improvement in optical quality and the growth of oriented crystals. $KZnF_3:Cr^{3+}$ and $SrAlF_5:Cr^{3+}$ crystals are recommended for the conversion of ruby laser radiation with a tunable range of 785 - 970 nm. Figures 5; References 25: 9 Russian, 16 Western.

UDC 577.3

Laser Spectrometer With Subpicosecond Time Resolution to Study Very Rapid Processes in Condensed Media

917J0001M Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1520-1525

[Article by Yu. A. Matveyets, A. G. Stepanov, S. V. Chekalin, and A. P. Yartsev, Institute of Spectroscopy, USSR Academy of Sciences]

[Abstract] A femtosecond-pulse laser can be used as the basis for a spectrometer with a time resolution of 10^{-13} - 10^{-14} s. Effective operation requires a very powerful laser, consisting of a generator plus a multistage amplifier. The active medium of the generator and the amplifiers is a dye solution, which achieves the shortest known pulses. The femtosecond laser spectrometer created at the authors' institute consists of a ring oscillator, four-stage amplifier and spectrometric section including a dual beam absorption spectrometer and flight-time mass spectrometer. A block diagram of the device is presented, plus results of experiments studying the first light-stimulated processes in photosynthesis reaction centers, as well as femtosecond desorption. Results are presented from studies of relaxation of excited charge carriers in semiconductor glasses at excitation intensities of 10^{11} - 10^{12} w·cm^{-2}. Figures 3; References 14: 8 Russian, 6 Western.

UDC 681.7:543.42

LAFIS-1 Ultrasensitive Automated Laser Atomic-Photoionization Analytic Spectrometer

917J0001N Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1526-1530

[Article by V. M. Apatin, G. I. Bekov, V. A. Beselov, V. V. Yermolov, I. V. Kolpakov, O. N. Kompanets, Ye. L. Mikhaylov, and A. G. Rukhlin, Institute of Spectroscopy, USSR Academy of Sciences]

[Abstract] The operating principle and design are described for the LAFIS-1 laser-photoionization analytic spectrometer, designed for highly sensitive determination of trace concentrations of elements in liquid and solid specimens. An experimental model of the instrument has been fabricated by the authors' institute together with the central design bureau for unique instruments, USSR Academy of Sciences. The device can determine ultratraces of most elements with a sensitivity as great as 10^{-10} percent. There are no matrix effects, measurements are quite rapid, the calibration graph has a long linear segment, and the processes of measurement and display of the data produced are automated. The equipment which the instrument consists of is based on series-produced modules or easily available components. The manufacturing technology of the individual optical-mechanical units and electronic modules is simple and can be easily reproduced in the laboratory or the plant. Figures 2; References 3: Russian.

UDC 621.373.826

Use of Tunable Lasers With Combined Excitation for Intraresonator Spectrum Analyzers

917J0001O Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1531-1535

[Article by A. N. Kolerov, G. Ye. Yepikhina, and N. M. Grachev, All-Union Scientific Research Institute of Physical-Technical, Electronic Measurements]

[Abstract] A description is presented on intraresonator laser spectrum analyzers based on solid-state lasers with flash-lamp excitation. Laser luminophor-based spectrum transformers are used to match the absorption band of the laser with the radiating spectrum of the pumping of flash lamp. Examples are presented on the practical implementation of such spectrum analyzers. References 12: Russian.

UDC 621.373.826.038.825.3

Express Diagnosis of Ecologic State of Baikal by Use of Color-Center Lasers

917J0001P Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1536-1542

[Article by V. A. Chepurnoy, Irkutsk State University]

[Abstract] Results are presented from experiments on the use of a compact, portable multifrequency lidar based on a solid-state laser to monitor the ecology of Lake Baikal. The multifrequency laser was designed to use the effect discovered by the authors on intraresonator energy conversion in a passive laser gate based on an LiF single crystal with F_2^- centers and the radiation of three long-wave transitions with subsequent transformation of the radiation to harmonics and sum frequencies. The multifrequency lidar produced is found to be quite sensitive, capable of recording light emitted by phytoplankton even during the season when the biomass of algae in Baikal is very slight. The studies revealed the possibility in principle of using information on the composition and variety of Baikal waters by multifrequency laser spectroscopy. Figures 3; References 12: 9 Russian, 3 Western.

UDC 535.33:539.2:621.375.826

Electronically Tunable Lasers Based on Condensed Media

917J0001Q Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1543-1551

[Article by V. I. Kravchenko and Yu. N. Parkhomenko, Institute of Physics, Ukrainian Academy of Sciences]

[Abstract] A study is made of the comparative characteristics of various methods of electronically tuning lasers based on the use of acoustooptic deflectors within the resonator to change the incident angle of the wave at the diffraction grating. High-speed, wideband tuning of a narrow radiation line and multifrequency generation with independent control of the intensity and position of the spectral components were achieved. This allows artificial synthesis of complex laser spectra of assigned structure, allowing the use of tunable lasers in problems related to correlation methods of analysis of optical signals, including correlation spectroscopy, optical communications and laser environmental sensing. Figures 6; References 24: 17 Russian, 7 Western.

UDC 535.21:539.43

Mechanism of Breakdown of Transparent Dielectrics by Nanosecond Laser Pulses. Nonlinear Generation of Color Centers

917J0001R Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1552-1556

[Article by S. K. Balitskas, P. Y. Bal'kyavichyus, Y. A. Gul'binas, A. A. Zhilenis, Y. P. Lukoshos, E. K. Maldutis, S. V. Sakalauskas, and S. Y. Yatsinavichyus, Institute of Physics, Lithuanian Academy of Sciences]

[Abstract] An experimental verification was conducted of a suggested model of laser breakdown of optical materials, considering that the laser radiation performs multiphoton generation of free charge carriers, the free carriers additionally absorbed laser radiation, heat is liberated in the volume, the temperature rises and the index of refraction of the class changes, the beam is compressed and the radiation intensity increases, accelerating the process. Under certain conditions the speed of this runaway chain increases very rapidly, and there is a great increase in the concentration of charge carriers and the liberation of energy, causing breakdown. The study is directed at two questions: Does the formation of color centers actually occur? Do they influence the breakdown of the glass? The answer to both questions is Yes. Figures 3; References 5: Russian.

UDC 535.212:539.4

Mechanism of Free-Carrier Generation in K8 Glass by Pulses of 1.06 μm Laser Radiation

917J0001S Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1557-1559

[Article by S. K. Balitskas, E. K. Maldutis, and S. V. Sakalauskas, Institute of Physics, Lithuanian Academy of Sciences]

[Abstract] A two-stage process is suggested for the generation of free carriers in glass struck by laser pulses, involving intermediate generation of radiation harmonics. In the specific case of radiation with λ_1 = 1.06 μm and K8 glass the generation of a free carrier occurs as follows: first, the third harmonic of the radiation is excited in the glass (λ_3 = 0.355 μm), then experiences two-quantum absorption. The theoretical analysis and experimental studies performed demonstrate that this mechanism can be one of the main causes of generation of free charge carriers. References 6: 3 Russian, 3 Western.

UDC 535.212:539.4

Effect of Train of Nanosecond Pulses on Optical Glasses and Crystals

917J0001T Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 54 No 8, Aug 90 pp 1560-1564

[Article by A. V. Mar'in, V. V. Radchenko, and T. N. Yas'ko, Scientific Research Institute of Nuclear Physics; Moscow State University imeni M. V. Lomonosov]

[Abstract] A study is presented on the characteristics of breakdown of certain transparent media upon multiple exposure to laser pulses with high repetition frequency. The study was conducted in order to answer the question as to whether the accumulation effect occurs, reducing the threshold of optical breakdown upon exposure to a sequence of laser pulses in comparison to the threshold for a single pulse. Studies were performed on several types of glass as well as lithium tantalate and niobate crystals exposed to a train of nanosecond pulses at 1.06 μm wavelength with various durations and repetition frequencies. A clear accumulation effect was observed in some types of glass at certain pulse lengths and pulse repetition frequencies. The accumulation effect is apparently related to the fact that a semiconductor microcrystal in the glass, when heated to a temperature above a certain critical point, can significantly change the resistance of the glass to repeated pulses. Figures 4; References 14: 13 Russian, 1 Western.

UDC 621.373.826:543.52

Influence of Photostimulated Processes on Radiation Absorption Index in Lithium Niobate Crystals

917J0001U Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 54 No 8, Aug 90 pp 1565-1568

[Article by V. A. Pashkov, O. Ye. Sidoryuk, and S. B. Topchiy, "Polyus" Scientific-Production Association]

[Abstract] A study is made on the question of the influence of radiation at 0.53 μm wavelength on the absorption in the near IR band at 1.06 μm. The inverse problem is also studied: the variation of the absorption index in the visible range with illumination by radiation at 1.06 μm. The results obtained provide a key to a more complete analysis of the process of laser breakdown of lithium niobate crystals in frequency doubler mode. As in the photorefractive effect, photostimulated absorption in lithium niobate crystals is apparently related to the presence of several impurities or internal defects in centers in the forbidden zone of the crystal and their charge modification as they are illuminated.

UDC 539.12

Determining Neutron's Charge Form Factor Without Using Longitudinally Polarized Electron Beams

907J0120A Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 35 No 7, Jul 90 pp 967-974

[Article by G. I. Gakh, Engineering Physics Institute at the Ukrainian Academy of Sciences, Kharkov]

[Abstract] Precise knowledge of electromagnetic form factor of nucleons is necessary for unambiguously interpreting experimental data obtained during the electron scattering by nuclei, especially in the area of high transferred energy and momenta, i.e., the area where nonnucleon degrees of freedom are manifested in nuclei. Polarization of protons forming during the fission of vector-polarized deuterons by nonpolarized electrons is theoretically analyzed and the polarization sensitivity to the form factor, as well as various deuteron wave function parametrizations, is analyzed in the framework of a relativistic momentum approximation. A new method is suggested for determining the charge form factor of a neutron which does not call for using longitudinally polarized electron beams. It is shown that in the quasielastic peak area, certain spin transfer coefficients are high, and sensitive to the form factor, and virtually independent of the deuteron wave function selection. References 21: 6 Russian, 15 Western; figures 6.

UDC 538.913

Coupled Quasi-Biphonon Vibrations of Fractal Lattice

907J0123A Leningrad FIZIKA TVERDOGO TELA in Russian Vol 32 No 6, Jun 90 pp 1613-1621

[Article by O.A. Dubovskiy and A.V. Orlov]

[Abstract] Coupled quasi-biphonon two-particle vibrations of the most common fractal lattice, a Sierpinski carpet, are analyzed for the purpose of determining their spectrum and comparing it with the spectrum of its one-particle states. The calculations are based on the model Hamiltonian H in the secondary-quantization representation, taking into account anharmonicity of vibrations that are of third and fourth orders with respect to displacements of oscillators such as hydrogen atoms in metal or molecular complexes in a molecular crystal, oriented perpendicularly to the fractal plane, also on the Schroedinger equation H|2 = E|2 and dispersion equation which its solution yields. A triangular Sierpinski carpet with cyclic boundary conditions is considered, including interaction of nearest neighbors. The method of theoretical calculations is analogous to the E.Domany-S.Alexander-D.Bensimon-L.P.Kadanoff method for one-particle states (PHYSICS REVIEW B Vol 28 No 6, 1983), but it yields a cubic rather than quadratic recurrence relation for $x_i = 2A_i$ E - S(E). The spectrum of A_i eigenvalues was calculated on a Standard System 1061 computer, also the spectrum of E_i eigenvalues corresponding to fixed values of the anharmonicity constant A (E - biphonon energy). Calculations for E - $2E_0$ = -8 V, -9 V, and -10 V (E_0 - energy of natural vibrations) indicate that, as A decreases, the edges of the spectrum in the (E,A) plane approach the edge of the band of two independent one-particle state E - $2E_0$ = -4 V. As the bond energy |E - $2E_0$| decreases, the high-frequency edge E_{hf} shifts proportionally to $2(E_0 - A)$ and the low-frequency edge E_{lf} shifts toward the edge of the band of dissociated two-particles states corresponding to A = 0. The authors thank V.M. Agranovich and A.G. Malshukov for helpful comments. Figures 2; references 17.

Focusing System of Quadrupole Lenses for Formation of High-Energy Neutrino Beams

907J0124B Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 60 No 6, Jun 90 pp 92-96

[Article by V.I. Garkusha, V.P. Kartashev, V.I. Kotov, and F.N. Novoskoltsev]

[Abstract] A linearly focusing system for formation of high-energy neutrino or antineutrino beams is described which can operate continuously or quasi-continuously with simple power sources. It consists of a triplet of quadrupole objective lenses with 40 mm diameter apertures, followed by a field-confining matching set of four magnets with an absorber between the second and third, followed by another triplet of quadrupole objective lenses with 100 mm diameter apertures. All lenses are made of lithium. Those in the first set are respectively 4 m, 8 m, 4 m long and those in the second set are respectively 6 m, 9 m, 6 m long. Each of the first three magnets has a 40 x 300 mm^2 effective aperture and is 9 m long. The fourth magnet has a 100 x 160 mm^2 aperture and is 12 m long. The distances of these lenses and magnets from the target are successively 7.5 m, 15.0 m, 22.5 m, 30 m, 50.5 m, 69.5 m, 89.5 m, 156 m, 165 m, and 174 m. Quadrupole lenses, unlike axisymmetric ones, focus not only a π,K-meson beam but also the antiparticles. When a neutrino beam is to be formed, this focusing system passes the beam of protons which have not interacted with the target. When an antineutrino beam is to be formed, however, those protons are dumped into the absorber. For control purposes, moreover, a collimator facing the absorber is also inserted between the two inner magnets. The system was tested in the neutrino channel of an undelayed channel amplifier with a broad spectrum, the accelerated proton beam having an energy of 3000 GeV and the decay base being 4 km long. Essential for the design of this focusing system is the dependence of its optimum length on the energy of the primary protons, with a constant magnetic inductance, the minimum length of the optimum focusing system is not dependent upon their energy over a wide range of momentum of the secondary particles. The ratio of the optimum length of the focusing system with quadrupole lenses to the length of the decay base becomes less favorable with decreasing energy of the primary protons, inasmuch as the length of the decay is usually much smaller than the radiation length for π-mesons. Figures 6; references 5.

New Form of Magnetism: Aeromagnetism

907J0125D Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 52 No 3, 10 Aug 90 pp 796-799

[Article by N.A. Tolstoy and A.A. Spartakov, Leningrad State University]

[Abstract] Experiments with microcrystals of aromatic compounds which have a planar molecular structure and no substituting elements or groups in their rings have revealed heretofore unknown properties, namely magnetic properties, of these crystals when suspended in water or other liquids such as dilute aqueous solutions of D_2O, HCl, CCl_4, KOH, H_2SO_4, and pure mineral oil. Orientating these microcrystals, aspherical ones, in a light beam was found to be accompanied by biaxial scattering of light, a biaxial Tyndall effect, and conservative dichroism. Periodic change of their orientation in a rotating magnetic field of constant magnitude at a constant speed ω was found to modulate the light transmitted by them periodically at a frequency 2ω, this modulation indicating a constant magnetic moment. Owing to viscous friction, the resultant axis of crystal orientation lagged the axis of the rotating magnetic field by an angle α. This angle remained constant when the magnetic field intensity H and the speed of rotation ω were varied so that the ratio ω/H remained constant. The substances tested (anthracene, phenanthrene, naphthacene, triphenylene, p-terphenyl, pentacene, benzo(def)phenanthrene, benzo(ghl)-perylene, picene, 1,2,6,7-dibenzoperylene, also azulene) are superior dielectrics without free electrons. Although their molecules are anisotropically diamagnetic, their collective diamagnetism being strong but without a spin so that they cannot become paramagnetic, their crystals evidently are stable permanent magnets. Something other than the spin mechanism must, therefore, be responsible for this new form of magnetism arbitrarily called aeromagnetism. Figures 1.

Cosmological Evolution of Neutrino Balls

907J0133A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 98 No 2, Aug 90 pp 369-376

[Article by A.D. Dolgov and O.Yu. Markin Institute of Theoretical and Experimental Physics]

[Abstract] The phenomenon of neutrino balls, a special kind of nontopological solitons with a characteristic tera-electron-volt energy scale (B. Holdom, PHYSICS REVIEW D Vol 36, 1987), is analyzed on the assumption of massless left-hand Majorana neutrinos and heavy right-hand ones above a chirally degenerate L-vacuum and R-vacuum respectively. Domain walls separating the two vacua, and bubbles of one vacuum in the other tend to collapse under the forces of surface tension when the left-right symmetry is spontaneously broken, but in this case the process is inhibited by the pressure of the massless neutrinos unable to escape through the surrounding body of heavy ones. In the cosmological problem of domain walls with a high energy density constituting excessively pronounced inhomogeneities, this difficulty is avoided in models of already broken left-right symmetry so that the probability of an L-vacuum forming will be higher than the probability of an R-vacuum forming and the space occupied by the latter can be regarded as sufficiently small. The evolution of a neutrino ball after its formation having already been described by B. Holdom and its explosive depletion by decay into photons in the $\nu_R \nu_R \rightarrow 3\,gg$ reaction (decay into 2γ being possible only in second-order weak interaction) while it cools down having already been examined, another possibility is considered. This possibility is depletion by accretion of matter and subsequent annihilation in the $\nu_R \nu_R e^- \rightarrow e^-\gamma$ reaction. The speed of this reaction is calculated with the aid of basic relations and Feynman diagrams. The accretion of matter on a neutrino ball prior to this reaction is then evaluated, taking into account not only its loss of mass as a result of depletion and its internal pressure but also the time necessary for accretion of matter from large distances and the pressure of radiation from a star. This latter pressure and the loss of mass tend to slow down the accretion process, the process being most intense after hydrogen recombination within the universe and thus at temperatures below 3000 K. Cosmological implications of the possible existence of neutrino balls are discussed, a neutrino ball with a large mass (up to 10^{41} g or 10^8 times larger than the sun mass) and a long life (up 10^{10} years) being a likely source of activity in galactic centers or of energy for quasars. When the chemical potential of a neutrino gas is of the order of half the electron mass, then the energy of emitted photons can be sufficient for generating electron-positron pairs. The authors thank V.K. Dubrovich for helpful discussions. Figures 2; references 8.

Quantum Theory of Nonlinear Propagation of Schroedinger Solitons: Compressed State and Sub-Poisson Statistics

907J0133B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 98 No 2, Aug 90 pp 407-418

[Article by A.V. Belinskiy and A.S. Chirkin, Moscow State University imeni M.V. Lomonosov]

[Abstract] A quantum theory of Schrödinger solitons propagating through an optically nonlinear medium is developed, beginning with derivation and solution of the nonlinear Schrödinger operator equation for the electric field of a soliton in continuous-integral form on the basis of the second-order dispersion theory. With this tool, the evolution of quantum fluctuations in the time domain is then analyzed, without resorting to the parametric approximation and including their attenuation by one of a soliton's quadrature components. It is shown, with the aid of an operator corresponding to the formal "Green's function" kernel, that an initially coherent soliton becomes compressed while propagating through a nonlinear medium. The statistical characteristics of soliton field intensity fluctuations are estimated on the basis of

the number-of-photons statistics, which remain Poisson statistics during propagation of a soliton through a nonlinear medium but can be transformed into sub-Poisson statistics by interference of the soliton and coherent light after the soliton has emerged from that medium. First, amplitude modulation and phase modulation of a soliton are evaluated comparatively, optimum phase modulation with the same time dependence of the Fano factor as optimum amplitude modulation but with a slightly larger dispersion found to require a more substantial change of the number-of-photons statistics. Next, two special cases are numerically analyzed, both the Fano factor and the dispersion of the number-of-photons fluctuations, which in each case different functions of time are normalized to the soliton duration in the system of coordinates which moves with the soliton. In the most favorable first case, a soliton mixes with continuous light waves whose constant amplitude and phase are optimum for the soliton crest. In the most unfavorable second case, a soliton mixes with another one which has a different amplitude only, their other constant parameters being optimum for the time t = 0 point. In both cases the number of photons in the soliton is characterized by substantially sub-Poisson statistics. The authors thank S.A. Akhmanov, D.N. Klyshko, and V.I. Tatarskiy for discussion and crucial remarks. Figures 4; references 15.

Angular Characteristics of Radiation Emitted by Relativistic Electrons in Matter

907J0133C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 98 No 2, Aug 90 pp 571-583

[Article by N.V. Laskin and A.I. Zhukov, Kharkov Institute of Engineering Physics, UkSSR Academy of Sciences]

[Abstract] Radiation emission by relativistic electrons in matter is analyzed from the standpoint of Brownian movement, multiple scattering of such electrons in a crystal by atom chains along the crystallographic z-axis rather than by individual atoms being described in terms of a varying deflection angle vector of the velocity vector and accordingly treated as the sum of its many random, independent, and small changes. New relations are then obtained by integration over the electron trajectory, which describe the effect of this multiple scattering of relativistic electrons on the spectral-angular distribution of coherent radiation emitted by them and also on its polarization. These relations are analyzed numerically for a 40 GeV electron and 200 MeV photons in a cT = 0.1 mm thick oriented tungsten crystal, and in a cT = 0.1 mm thick disoriented one equivalent to an amorphous tungsten target. Figures 8; references 11.

Probabilities of E2-Transitions and Mean Electric Quadrupole Moments of Excited States With Large Moments in Phenomenological Collective Model of Nucleus

907J0135A Moscow YADERNAYA FIZIKA in Russian Vol 52 No 2(8), Aug 90 pp 390-394

[Article by A.A. Seregin, Institute of Power Physics, Obninsk]

[Abstract] Predictions by the phenomenological collective A.P. Budnik model of an atomic nucleus (YADERNAYA FIZIKA Vols 15 and 16, 1972) pertaining to probabilities of E2-transitions and mean electric quadrupole moments of excited states with large angular momentum are verified by the adequate amount of experimental data on almost spherical ^{150}Sm, ^{154}Dy, ^{156}Er and very oblate $^{192,194,196}Pt$ nuclei available since then. This model has been derived from the phenomenological collective Bohr-Mottetlson model with a five-dimensional Schroedinger equation covering not only the kinetic energy of rotations but also the kinetic energy of β-vibrations and γ-vibrations. With the potential energy of collective motions assumed to be $V(\beta,\gamma) = a + b\beta + c\beta^2 + d\beta \cos 3\gamma$, it is minimum when $\beta = \beta_0$ and $\gamma = \gamma_0 = 0$. The number of parameters has been reduced to three: $\varepsilon_i(J) = E_i(J) / E_i(2)$, $B(E2;J,i \rightarrow J',i') / jB(E2;2,1 \rightarrow 0,0)$, (average $Q_2)_{J,i} / Q_0$. All three are functions of only two dimensionless parameters in that Schroedinger equation: $y_0 = (\beta/\beta_{00})_0$ and $\alpha = C_\gamma / 9C_\beta$ where $C_\beta = \delta^2V / \delta\beta^2$ at minimum V and $C_\gamma = \delta^2V / \delta/\gamma^2$ at minimum V divided by β_0^2. The closeness of the experimental data to the theoretical data validates this model as an adequate tool for predicting as well as classifying properties of excited states of even-even nuclei. The author thanks Z.V. Rudneva and G.V. Slesarev for assistance in laying out the project. Figures 4; references 10.

Production of Photons in Nuclear Collisions

907J0135B Moscow YADERNAYA FIZIKA in Russian Vol 52 No 2(8), Aug 90 pp 447-557

[Article by D.N. Voskresenskiy and A.V. Senatorov, Moscow Institute of Engineering Physics]

[Abstract] Reactions which involve production of photons in nucleus-nucleus collisions are analyzed, considering that local thermodynamic equilibrium establishes itself after two or three collisions to be followed by hydrodynamic compression and subsequent expansion of the nuclear medium. The differential cross-section for photon production is calculated, therefore, by including effects of the nuclear ambient medium in accordance with Pauli's exclusion principle and by adding the contribution of the first few (np)-collisions. Collision of nuclei is presumed to give fast rise to a nuclear fireball which, after initially being at quasi-equilibrium, continues to expand slowly under its internal pressure and then collapses. Eventually the nucleons cease to collide with one another and their momentum distributions become "frozen" so that particles produced in NN-collisions, after having been confined within the fireball, become free. Photon production in NN → NN γ processes involves photon production by outer nucleon and from intermediate states. Calculations reveal that the mean free path for high-frequency photons ($\omega_\gamma > T$ - temperature of fireball, Planck constant = speed of light = 1) is longer than the characteristic dimension of a nuclear fireball so that the probability of a photon being produced in an NN-collision is analogous to that of a neutrino being produced by the matter of a neutron star, while the mean free path for a

low-frequency photon ($\omega_\gamma < T$) is shorter than that dimension and photons are produced only during the final stage of fireball evolution. Photon production in np → np γ processes involves both neutral and charged channels. Photon production in reactions with production or absorption of real π-mesons and the contribution of Δ(1232)-isobars are disregarded, only light collisions with an energy up to 1 GeV/nucleon being accordingly considered. The almost linear dependence of the fireball temperatures at the instant of maximum compression T_m and at the instant of collapse T_b on the nuclear collision energy in the center-of-mass system of coordinates has been evaluated over the 0 - 100 MeV range of that energy, T_m exceeding 60 MeV and T_b exceeding 40 MeV when the collision energy reaches 100 MeV. Next is calculated the invariant differential cross-section for production of up to 200 MeV photons by the $^{36}Ar + ^{27}Al \rightarrow X + \gamma$ reaction with 85 MeV/nucleon at 150°, 90°, and)angles. The results of this calculation according to the authors' equation for high-frequency based on a modification of the Valecky model agree closely with experiment data. Calculations for low-frequency photons take into account their dispersion and polarization within the nuclear medium prior to their release upon collapse of the fireball, which can be regarded as occurring instantaneously. . For comparison, the invariant differential photon production cross-section is also calculated according to the blackbody law for inclusive processes. Figures 5; references 22.

Noncoherent Source of High-Energy γ-Radiation in Reactions Involving Heavy Ions at Intermediate Energy Levels

907J0135C Moscow YADERNAYA FIZIKA in Russian Vol 52 No 2(8), Aug 90 pp 458-464

[Article by I.S. Batkin and I.V. Kopytin, Businesslike Organized Scientific Association at Voronezh State University]

[Abstract] Noncoherent emission of high-energy photons during reactions involving multiply-charged ions at intermediate energy levels is analyzed in accordance with the authors' model of photon emission as a peripheral process during "slowdown" of nucleons of a colliding nucleus in the field of the partner nucleus, considering that this "slowdown" is coherent when nuclei with different Z/A ratios collide and much less coherent when nuclei with close Z/A ratios collide. In the latter case, especially at low velocities of the transferred ion relative to the speed of light, the dipole component of radiation decreases while its quadrupole component remains small proportionally to the ion velocity squared and the noncoherent component increases so that the radiation pattern approaches an isotropic one. The differential photon emission cross-section is calculated with the aid of the electromagnetic radiation operator for each of two colliding nuclei, after the corresponding center-of-gravity coordinate has been extracted. The yield of 30 - 120 MeV photon emission has been calculated for ^{20}Ne (30 MeV/nucleon) + ^{24}Mg, ^{6}Li (30 MeV/nucleon) + ^{208}Pb, ^{40}Ar (30 MeV/nucleon) + ^{40}Ca, ^{208}Pb, ^{14}N (30,40 MeV/nucleon) + ^{12}C, ^{208}Pb, ^{40}Ar (44 MeV/nucleon) + ^{158}Gd, ^{86}Kr (44 MeV/nucleon) + ^{108}Ag, ^{197}Au, ^{12}C (84 MeV/nucleon) + ^{238}Ur reactions. The results, supported by experimental data, indicate that photon emission, due to the noncoherent component in the collision process, can be comparable with or even exceed photon emission due to the coherent one. Figures 6; references 14.

Multiplicity Fluctuations of High-Energy Muons Generated by Nuclei in Primary Cosmic Rays

907J0135D Moscow YADERNAYA FIZIKA in Russian Vol 52 No 2(8), Aug 90 pp 500-507

[Article by S.N. Boziyev, Institute of Nuclear Research, USSR Academy of Sciences]

[Abstract] Multiplicity fluctuations of high-energy muons generated by nuclei with atomic weights A = 1,4,5,6 and energy E_0 = 1 - 10,000 TeV/ nucleon in primary cosmic rays are analyzed by the Monte Carlo method on the basis of statistical data pertaining to an 840 g/cm^2 depth in the atmosphere, such a depth corresponding to the underground level of the Baksan scintillation telescope. Generation of muons through charged π-mesons and K-mesons is considered, these mesons being generated in interaction of primary nuclei and air nuclei (mean A = 14.7), in accordance with the quark-gluon jet model and the multiple scattering model. A linear dependence of the cross-section for inelastic interactions of the various hadrons and an air nucleus on the initial hadron energy or on its logarithm is selected, also a negative power-law dependence of the air pressure on the altitude up to 11 km and an inverse exponential one above 11 km. The results of calculations put in the form of histograms yield (approximately) a negative binomial distribution of muon multiplicity fluctuations which is slightly or much wider, depending on the hadron energy and on the atomic weight of the primary nucleus, than would a Poisson distribution. For a comparison with experimental data based on detection of muon groups, finite dimensions of the recording apparatus are taken into account. The author thanks A.Ye. Chudakov and A.V. Voyevodskiy for interest and valuable comments, Yu.M. Andreyev and O.V. Suvorova for assistance in computer-aided calculations. Figures 4, tables 3; references 17.

UDC 537.533

Use of Scanning Tunneling Microscopy to Determine Sample Surface Roughness in Elastically Reflected Electron Spectroscopy

907J0120B Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 35 No 7, Jul 90 pp 1073-1075

[Article by V. A. Kanchenko, Yu. N. Krynko, I. V. Lyubinetskiy, P. V. Melnik, N. G. Nakhodkin, Kiev State University imeni T. G. Shevchenko]

[Abstract] Within the framework of an earlier model, the joint effect of the surface roughness and electron refraction on the spatial distribution of electrons elastically reflected from nonordered solids, particularly a gold film target, is considered. The surface topology was examined by a scanning tunneling microscope which can produce three-dimensional images with a high spatial resolution along all the coordinates. It is shown that under the conditions of the incidence of primary and emergence of elastically reflected electrons being recorded, the surface roughness does not result in significant quantitative changes in the spatial distribution of elastically reflected electrons. The use of scanning tunneling microscopy makes it possible to obtain surface topograms and determine the parameters necessary for taking the surface roughness into account in elastically reflected electron spectroscopy. References 4: 2 Russian, 2 Western, figures 2.

UDC 621.373.826

Wavefront Inversion Precision During Degenerate Six-Photon Interaction

907J0121B Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 33 No 7, Jul 90 pp 100-102

[Article by V. V. Ivakhnik, V. I. Nikonov, Kuybyshev State University]

[Abstract] In addition to four-photon processes, six-photon processes can make a considerable contribution to the wavefront inversion wave during a degenerate parametric interaction. The accuracy of the wavefront inversion during a six-photon parametric interaction as a function of the Gaussian pump wave focusing degree into a nonlinear medium as well as one pump wave rotation relative to the other is examined. A standard four-wavefront inversion scheme where two pump waves propagating toward each other, and a signal wave and an object wave are incident upon a nonlinear medium shaped as a plane layer is considered. The wavefront inversion accuracy is estimated by the blurring of the point source image located at the center of the field of view. The spread function fully describes the relation between complex amplitudes of the signal and object waves. A numerical analysis shows that the spread function modulus decreases monotonically with an increase in the nondimensional coordinate while the spot phase variations are insignificant. Thus, the resolution which is estimated by the half-width of the spread function can serve as the wavefront inversion accuracy criterion. The behavior of the six-photon radiation converter resolution as a function of focusing of the pump waves and their relative rotation does not change with a transition to other observation plane positions. References 4: 2 Russian, 2 Western; figures 2.

UDC 536.242

Supersonic Propagation of Phase Transition Front

907J0123C Leningrad FIZIKA TVERDOGO TELA in Russian Vol 32 No 6, Jun 90 pp 1806-1811

[Article by A.Z. Patashinskiy and M.V. Chertkov, Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] Phase transition of the first kind in a system with a scalar order parameter φ is considered and supersonic propagation of the transition front in such a system is analyzed from the standpoint of the effect of an acoustic field on that order parameter. The fundamental equation $\delta\varphi/\delta t = -\Gamma\delta H\ [\delta f]/\delta\varphi$ describes the kinetics of the order parameter φ during relaxation of a metastable phase with (φ+) into a stable phase with (φ-) by relating its rate of change to the effective system Hamiltonian H, the coefficient Γ being constant in the case of a nonconservative order parameter. This equation is applied to a moving phase transition front, not only much wider than interatomic distances and thus characterizing a nearly continuous phase transition, but also to one which satisfies the Ginzburg-Levanyuk criterion for smallness of fluctuations. The equation of motion for the transition front is formulated in terms of the scalar density field similarly related to the effective system Hamiltonian, with the strain tensor defined in terms of density buildup as a result of deformation. The temperature field can be ignored, thermal expansion being a linear process with respect to temperature as well as to density and thus merely correcting the striction coefficient. Both order parameter relaxation and transition front propagation are, moreover, regarded as adiabatic rather than isothermal processes. Interaction with the acoustic field is included by implicating the speed of sound in the equation of motion. These two simultaneous equations are then, after normalization of their variables, solved for a plane phase transition front and an initially undeformed metastable phase, in the approximation of constant and equal speeds of sound in the two phases each with the same thermal conductivity and specific heat. A stability analysis of the solution in the (v,-h) plane, (v - velocity of the phase transition front, h - intensity of the external field) reveals that there is range of field intensity from $-h^-$ to $-h^+$ within which no plane front exists but above and below while a plane phase transition front remains stable. Figures 2; references 3.

Optical Examination of $Al_2O_3:Ti^{3+}$ Crystals in Electric Field: Revealing Two-Stage Photoionization of Ti Ions and Linear Stark Effect in Their Spectra

907J0123D Leningrad FIZIKA TVERDOGO TELA in Russian Vol 32 No 6, Jun 90 pp 1898-1900

[Article by S.A. Basun, A.A. Kaplyanskiy, V.K. Sevastyanov, L.S. Starostina, S.P. Feofilov, and A.A. Chernyshev, Institute of Engineering Physics imeni A.F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] Photoionization of Ti ions in Al_2O^3: Ti^{3+} crystals was studied in an experiment involving measurement of their photoconductivity at 77 K temperature, such crystals having been grown by the Czochralski method with electrical resistance heating. An electric field of the order of 100 kV/cm intensity was applied through optically transparent electrodes to about 0.2 mm thick slices of corundum containing 0.2% Ti. The photocurrent was measured with an electrometer, following optical excitation of those slices through the electrodes, the electrometer having a time constant of the order of 1 s so that it could average the photocurrent following a pulsed excitation. No photocurrent was recorded following excitation with visible light of a continuous wave Ar-laser (514.5 - 457.9 nm) or of a pulsed Cu-laser (510.5 nm and 578.2 nm). Photocurrent was recorded only following excitation with ultraviolet light of a pulsed N_2 laser (337.1 nm), its average over the duration of a pulse found to increase proportionally to the light intensity squared as evidence of a two-quantum excitation mechanism. In a supplementary experiment, photocurrent was induced by exciting a crystal slice bilaterally with two synchronized pulsed lasers: the N_2 laser delivering pulses of 10 ns duration and 10 kW power at a repetition rate of 10 kHz, the Cu-laser delivering pulses of 20 ns duration and 10 kW energy. Incidence of a N_2 laser pulse could be made to lag behind, to coincide, or slightly lead the incidence of a Cu-laser pulse. With the N_2 laser pulse lagging more than 10 μs or slightly leading, the average photocurrent was the same as following excitation by the N_2 laser alone and was found to increase appreciably after delays up to 10 μs but more so after zero delay. These results are direct evidence of Ti^{3+} ions, with one electron in the d-shell, having been photoionized in two stages, through the intermediate $^2E(e)$ state by a pulse of visible light from the Cu-laser pulling that electron into the conduction band, to the final $^2E(t)$ state by a pulse of ultraviolet light, visible light from the N_2 laser pulling it into the valence band. The luminescence spectrum of a corundum (ruby) crystal with Ti ions at 77 K in an electric field parallel to its trigonal axis of the crystal revealed a symmetric quasi-Stark doublet split of the two phononless Ti^{3+} lines associated with transitions of these ions to sublevels of their ground state. The split was 1.7 x 10^{-4} cm^{-1} / (V/cm), much wider than the analogous quasi-Stark split in the luminescence spectrum of a pure ruby crystal. Figures 3; references 4.

New Ways to Study Phonon Spectrum of Crystals With Perovskitic Structure

907J0125A Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 52 No 3, 10 Aug 90 pp 793-796

[Article by V.I. Makarov, G.M. Vereshkov, Yu.M. Gufan, and V.S. Klochko, Kharkov Institute of Engineering Physical, UkSSR Academy of Sciences, and Rostov State University]

[Abstract] New ways to study the phonon spectrum of a crystal with a soft mode by acoustic spectroscopy are proposed and demonstrated. Such a study was made concerning the anisotropic temperature dependence of the longitudinal acoustic velocity in a La_2CuO_4 single crystal. That study revealed a surprisingly large difference between the temperature dependence of the speeds of sound $c_{[100]}$ and $c_{[110]}$ in the basis plane, contrary to conventional theory of sound-phonon interaction in crystals with a perovskitic structure. Interaction of sound waves and a certain type of phonon mode, namely a soft one, is shown to be responsible for this anisotropy. For the purpose of proving this, the phonon parts of all components of the elasticity tensor $\lambda_{ik\ em}$ and of the viscosity tensor $\eta_{ik\ em}$ are calculated according to the theory of sound propagation through crystals. They calculated for a La_2CuO_4 crystal in which the tetragonal phase is predominant, a small admixture of the orthorhombic phase does not significantly influence the physical factors responsible for the anisotropy of acoustic properties in the basis plane. While the contribution $\lambda_{ik\ em}{}^{(1)}$ of optical and acoustic phonons does not appreciably influence the anisotropy in the basis plane, the contribution $\lambda_{ik\ em}{}^{2}$ of E-modes is found to be responsible for it. In order to interpret the experimental data accordingly, it has been necessary to classify the E-modes with mutually orthogonal polarization vectors in the basis plane with respect to the removal of degeneracy, i.e., with respect to the structure of anisotropic $\gamma_{ik}{}^{E}$ tensors defining the geometrical properties of isoenergetic surfaces $\gamma_{ik}k_ik_k$ = const. The temperature dependence of the acoustic anisotropy $A(T) = A_1(T) + A_2(T)$ can now be calculated in terms of those two speeds of sound at zero absolute temperature and four responsible phonon contributions $\lambda_{1111}{}^{(1),(2)}, \lambda_{1212,1122}{}^{2}$ with the density of the crystal ρ known. When $c_{[110]}(0) = c_{[100]}(0)$ even approximately, then A_1 vanishes and the algebraic sign of A(T) becomes a reliable indicator of the type of wave generating a soft mode, and the frequency of the latter can be estimated on the basis of the temperature range within which the A(T) function steeply rises. The second term A_2 of that function has been calculated for the temperature range below $\hbar\omega_{0E}$, where $\sigma(T)$ = const. The authors thank N.V. Zavaritskiy for discussing the results. Figures 1; references 5.

Observing Evanescent and Standing X-Ray Waves Within Region of Total External Reflection by Molecular Langmuir-Blodgett Layers

907J0125B Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 52 No 3, 10 Aug 90 pp 804-808

[Article by S.I. Zheludeva, M.V. Kovalchuk, N.N. Novikova, I.N. Bashekhlanov, V.Ye. Yerokhin, and L.A. Feygin, Institute of Crystallography, USSR Academy of Sciences, S. Lagomarzino, Institute of Solid-State Electronics, Rome, Italy]

[Abstract] An experiment has demonstrated, for the first time, the presence of a standing x-ray wave and an evanescent x-ray wave within the total external reflection by a Langmuir-Blodgett film. A standing x-ray wave was detected upon recording the fluorescence by a double layer deposited on such a film and an evanescent x-ray wave penetrating that fi'm was detected upon measurement of the fluorescence by heavy atoms in the organic matrix. The specimen, a heterostructure with 100 monolayers of lead stearate on a silicon substrate and a bilayer of barium behenate on top, contained 50 diffraction planes 4.9 nm apart. The experiment was performed using the two-crystal diffraction scheme and symmetric (111)-reflection, with a Si monochromator crystal and a CrK_α source of 5.4 keV x-rays. A 50 μm wide slit behind the monochromator limited the width of the x-ray beam impinging on the specimen at a low angle. The intensity of their reflection was measured with a NaI scintillation counter. The characteristic fluorescence of PbM_α rays by the Pb-stearate matrix and of BaL_α rays by the Ba-behenate coating was recorded with a Si(Li) solid-state detector in a plane normal to the surface of the specimen. Calculations based on the Fresnel theory of reflection by multilayer structures and on the experimental data reveal an important feature of a standing x-ray wave within the region of total external reflection by such a structure, namely a strong dependence of its period D on the angle of incidence θ. Inasmuch as $D = \lambda/2\sin\theta$ (λ - wavelength of incident x-rays) can accordingly be very large, up to 100 nm, it becomes feasible by virtue of this relation to study layers of atomic thickness by x-ray spectroscopy with such a layer placed high above the reflecting surface. Figures 2; references 12.

Emission of Light by Tunnel Junction in Scanning Tunneling Microscope

907J0125C Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 52 No 3, 10 Aug 90 pp 830-832

[Article by I.I. Smolyaninov, M.S. Khaykin, and V.S. Edelman, Institute of Problems in Physics and Institute of Problems in Microelectronics and Extra-Pure Materials Technology, USSR Academy of Sciences]

[Abstract] A new method of recording light emitted by the tunnel junction in a scanning tunneling microscope has been developed. The tip of a 30 cm long metal-coated optical quartz fiber 200 μm in diameter serves as the probe, glued at its other end with Stycast-1266 adhesive to the entrance window of an FEU-79 photomultiplier operating the photon counter mode. This method was tested at room temperature in a configuration with a photon count covering a solid angle of almost π sr. It was tested on several tunnel junctions, gold films and platinum films deposited on either glass or metal substrates, using either a silver-coated or a gold-coated optical fiber as probe. The dependence of the luminescence intensity on the voltage between junction and probe was determined on the basis of about 50 measurements made with each probe above various spots on each junction, the 50 readings in each case having then been averaged. The tunnel current was varied over the 30 - 100 nA range, but held constant for each measurement by a feedback loop installed in the microscope. The results of this test confirm the theory of plasmon modes excited in a tunnel junction of any geometry, their frequencies not exceeding that of the surface plasmon with an infinitely large wave vector at a plane interface of two metals. The voltage dependence of the luminescence intensity is characterized by peaks within the 2 - 5 V range, at a different voltage for each junction metal and probe metal combination. It indicates a collective process, inasmuch as replacement of gold with silver as junction material has shifted the peak to a higher voltage rather than added another peak. The peak-intensity voltage is proportional to the frequency of a surface plasmon ω_{sp} eV, that frequency being equal to the square root of half the sum of the squares of two frequencies $\omega_{vp(1,2)}$ of volume plasmons in pure junction metal and in pure probe metal respectively. The magnitude of the proportionality factor is a useful basis for estimating the characteristic dimensions of microstructures or inhomogeneities on which a surface plasmon has been excited. The authors thank A.S. Borovik-Romanov for showing interest. Figures 2; references 7.

UDC 535.417

New Modification of Holographic Interference Spectroscopy

907J0131A Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 4, Jul-Aug 90 pp 82-85

[Article by I.S. Zeylikovich and A.M. Lyapikov, Grodno State University imeni Ya. Kupala]

[Abstract] A new variant of holographic interference spectroscopy is proposed which involves a'posteriori processing of a Puccianti spectrogram, the latter having been recorded with a wide-spectrum light source through a monochromator on photographic material so that the interference fringes run transversely across the entrance slit of the spectrograph and are spaced 10 - 20 mm^{-1} in the photodetector plane. The spectrohologram characteristics are analyzed in terms of transmittance amplitude

distribution over its surface, complex phase distribution over the diffraction zone, and intensity distribution over a plane optically coupled to the spectrogram. The degree of fidelity with which the recorded spectrohologram follows the wavelength dependence of the refractive index of the object medium is largely influenced by aberrations in both the interferometer and the spectrograph. An advantage of this method is its adaptability to double-exposure holographic interference spectroscopy (first exposure without object medium, second exposure with subject medium in one interferometer arm) with the use of a single light beam for processing spectrohologrames and obtaining interference patterns where fringes are horizontally adjustable so that the wavelength dependence of the refractive index in the vicinity of absorption lines can be duplicated within some given fidelity scale. Double exposure eliminates the adverse effect of aberrations. The method was successfully tested in an experiment using a Mach-Zehnder interferometer and, as light source, a dye laser pumped by a N_2 laser. Figures 1; references 5.

Nondegenerate Parametric Regeneration of Optical Ultrashort Pulses in Crystals

907J0134C Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian
Vol 16 No 14, 26 Jul 90 pp 45-50

[Article by D.M. Indenbaum, V.M. Sysuyev, and A.S. Shcherbakov, Leningrad Polytechnic Institute imeni M.I. Kalinin]

[Abstract] Nondegenerate parametric interaction of optical ultrashort pulses and quasi-continuous pump pulses in a quadratically nonlinear and noncentrisymmetric crystal is analyzed theoretically, considering this kind of interaction is relevant to regeneration of ultrashort pulses in fiber optic communication lines which operate in the soliton mode. For this reason, only pulses of the $\varphi = \mathrm{sech}(t/\tau_0$ form τ_0 pulse duration) are considered here with the phase of the idle wave matching the phase of the signal wave to the phase of the pump wave. The system of three coupled differential equations describing the evolution of three-wave interaction in such a crystal with exact phase synchronism, disregarding dispersive blur and optical losses, is solved for the real parts of slowly varying complex amplitudes of the three waves. In the first approximation, the signal wave and the idle wave have complex amplitudes with real parts much smaller than that of the complex amplitude of the pump wave, but they increase steadily. The boundary conditions at the point of origin in this approximation are complex amplitudes of the pump wave and the signal wave with finite real parts and a complex amplitude of the idle wave with a zero real part. In the second approximation, all three real parts are of the same order of magnitude, which represents an amplification of both signal wave and idle wave with an attendant depletion of the pump wave. This process is a nonsteady one, the envelopes of pulses in the signal wave and in the idle wave now tending to become compressed and the dip of the pump wave shifting. In the experimental study of this process, an InGaAsP/InP heterojunction laser with external cavity and active mode locking was used as source of 1.32 μm radiation, emitting signal pulses of 5 ps duration and 1 W power at a repetition rate of 700 MHz in a continuous sequence. As the medium for three-wave interaction and resulting regeneration of such ultrashort pulses, three $LiNbO_3$ crystals with autonomous adjustment for minimizing the drift of the pump wave were used, each 0.5 cm long and cut at a 11°30' angle to the optical axis so as to ensure oo-e synchronism. The pumping source was a YAG:Nd laser with frequency conversion which emitted pulses of 13 ns duration and 1 MW power in a beam with a 0.5 mm radius, boosting the ultrashort signal pulses by 57 percent. Figures 2; references 9.

UDC 533.951

Laser Plasma in Vacuum as High-Intensity Ultraviolet Radiation Source

907J0122A Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 59 No 1, Jul 90 pp 51-61

[Article by A.P. Golub and I.V. Nemchikov, Institute of Geophysics imeni O.Yu. Shmidt, USSR Academy of Sciences, Moscow]

[Abstract] An aluminum plasma generated by a CO_2 laser is considered a source of ultraviolet radiation, radiation in turn is emitted by such a plasma into a vacuum. The feasibility study involves an analysis of semiempirical relations and numerical estimates pertaining to a 1 cm thick plasma layer and moderate laser power density of 10^1 - 10^4 W/cm^2. The gas dynamic parameters of the plasma have been determined from the solution to the spherisymmetric problem of steady plasma expansion and vapor heating without reradiation. The high efficiency of laser energy to bremsstrahlung energy and recombination radiation energy indicates that such a laser plasma is optically transparent to both forms of radiation the principal contributors to the energy emitted by it being photons with an energy higher than the ionization potential at any given instant of time. The spectrum of emitted radiation consists of a plateau up to the ionization potential and a sharp peak followed by a steep exponential tail above that potential. A plasma heated by a CO_2 laser is found to be less intense than one heated by a Nd-laser under similar conditions. The evaluation of laser action on an opaque barrier target, such as a solid aluminum target, is based on a numerical solution of the spherisymmetric problem of nonsteady radiative gas dynamics. The flow of plasma is described by a system of two partial differential equations and its propagation along laser beam rays being described by an equation in the approximation of geometrical optics. The solution to the latter equation was extended up to the critical front surface, at which the plasma frequency becomes equal to the laser frequency, and was there spliced to the solution to the wave equation for the region beyond. Simulation of a laser plasma was done in two stages: 1) by determining the time till absorption of laser radiation in the presence of erosive vapor peaks sharply and 2) determining the distributions of gas dynamic parameters of the plasma "deflagrated" during this period of time. Calculations were made by the method of finite differences according to an implicit scheme, the three-point one, for the heat conduction and a completely conservative scheme for the gas dynamics. These calculations have yielded a maximum reradiation efficiency close to 75 percent for an aluminum plasma heated by a CO_2 laser with about 0.7 GW/cm^2 intensity and thus higher than the 50 percent maximum reradiation efficiency of such a plasma heated by a Nd-laser with an intensity higher than 10 GW/cm^2. Figures 5; references 27.

UDC 533.951

Calculation of Opticophysical Parameters of Multiply-Charged Plasma on Basis of Hartree-Fock-Slatter Method, Part 2: Mean and Mean-Group Absorption Coefficients

907J0122B Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 59 No 1, Jul 90 pp 62-65

[Article by B.N. Bazylev, L.V. Golub, G.S. Romanov, and V.I. Tolkach, Scientific Research Institute of Applied Problems in Physics at Belorussian State University imeni V.I. Lenin, Minsk]

[Abstract] For testing a time-efficient computer-aided calculation of the optical characteristics of plasmas on the basis of the Hartree-Fock-Slatter self-consistent field method, the Planck mean and mean-group absorption coefficients as well as the Rosseland mean and mean-group absorption coefficients have been calculated for aluminum and air plasmas over wide ranges of density and temperature: $\rho = 0.01$ - 0.00001 g/cm^3 and $\log T \approx -1.5$ - (1.5) for aluminum plasmas, $\rho = 0.003$ - 0.0000001 g/cm^3 and $\log T \approx 0$ - 2.5 for air plasmas. The values obtained as a result of calculations on a Standard System 1061 computer agree closely enough with values already found in the technical literature to allow using this method for numerical analysis of the radiative hydrodynamics of plasma formations. Figures 4; references 5.

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Modulation Instability and Formation of Solitons at Ion-Ion Hybrid Resonance

907J0127A Moscow FIZIKA PLAZMY in Russian Vol 16 No 8, Aug 90 pp 907-915

[Article by T.A. Davydova and V.M. Lashkin, Institute of Nuclear Research, UkSSR Academy of Sciences]

[Abstract] Modulation instability of plasma oscillations is analyzed in connection with high-frequency plasma heating in tokamaks by means of magnetoacoustic waves whose frequencies approach the ion-cyclotron frequency, experiments having confirmed the large role of ion-cyclotron and ion-ion hybrid resonances in absorption of these waves Both the linear initial stage and the subsequent nonlinear stage of this instability in a uniform alternating electric field and a constant magnetic field parallel to the principal torus axis are described, considering the presence of several kinds of particles, but at first disregarding nonuniformity of the pump wave. Modulation instability of a nonuniform pump wave is considered next, a nonlinear equation being derived which describes the dynamics of such an instability at the ion-ion hybrid resonance frequency. This equation is found to have soliton solutions, as demonstrated by splitting it into its real and imaginary parts and solving the Cauchy problem. Depending on the form of the pseudopotential, the soliton solution can be a bell curve or a cissoid. Figures 1; references 20.

UDC 533.951

Absorption of Plasmons by Langmuir Soliton

907J0127B Moscow FIZIKA PLAZMY in Russian Vol 16 No 8, Aug 90 pp 916-925

[Article by B.N. Breyzman, Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences]

[Abstract] The behavior of a Langmuir soliton in a gas of free plasmons is analyzed by including electronic nonlinearities, which may play some role in the dynamics of Langmuir turbulence even though they are generally much weaker than the "ionic" ones. They are accordingly treated as a small perturbation and the probability of capture of plasmons by such a soliton, and thus of their collisionless dissipation by this mechanism, is calculated, in the approximation of random phases, on the basis of nonlinear equations for the electric field in a plasma containing cold ions and nondecaying acoustic perturbations produced by the ponderomotive force. This process of their capture depends on the beats produced by free and bound plasmons, transition of plasmons from free to bound state being effected principally by an ionic mechanism when the beat frequency is lower than the ion plasma frequency but virtually by an electronic mechanism when the beat frequency is higher. Capture of plasmons, in this case following their scattering by electrons, is found to result in a compression of the soliton with an attendant boost of the Landau damping in the plasmon gas. References 8.

UDC 533.951

Ultrarelativistic Theory of Wake-Plasma-Wave Laser Accelerator

907J0127C Moscow FIZIKA PLAZMY in Russian Vol 16 No 8, Aug 90 pp 935-944

[Article by S.V. Bulanov, V.I. Kirsanov, and A.S. Sakharov, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Generation of a fast Langmuir wave in a plasma by an ultrarelativistic laser pulse is considered as a method of accelerating plasma particles, a theory of such a laser accelerator being outlined which focuses on the evolution of such a pulse. The theory is based on two Maxwell equations and the Rukhadze equation of relativistic electron hydrodynamics, collisions and thermal motion of the plasma electrons being disregarded while the plasma ions are assumed to be motionless. When a one-dimensional laser pulse of linearly polarized electromagnetic radiation propagates parallel to the longitudinal axis, while both longitudinal and transverse components of the electron velocity depend on both longitudinal and transverse components of the electron momentum, then these equations yield a transverse component of the electric field intensity proportional to the rate of change of the transverse momentum component and a magnetic induction proportional to the longitudinal momentum gradient. Another analogous system of three equations then describes longitudinal motion of plasma electrons in terms of the longitudinal momentum component in a parallel electrostatic field which segregates charges. Each set of two Maxwell equations reduces to an equation which represents the law of energy conservation in the "plasma-laser pulse" system. Assuming a plasma sufficiently rare so that the carrier frequency of the laser pulse is much higher than the plasma frequency and its velocity is close to the speed of light, assuming also that both longitudinal and transverse components of the electron momentum vary slowly in time, an equation is subsequently derived for the complex amplitude of the laser pulse or wave packet vector-potential. This equation is then simplified by discarding the terms nonlinear with respect to the electron momentum as well as the term with the second time derivative of the complex amplitude and thus assuming that the latter varies slowly in time. On the basis of this theory, the generation of a plasma wave by a laser pulse of given form and then the evolution of a laser pulse generating a nonlinear plasma wave are examined. The theoretical analysis of the problem is aided by a numerical solution of that equation for the complex amplitude of the laser pulse vector-potential. Inasmuch as this theory is based on the one-dimensional approximation of short relativistic laser pulses, it becomes necessary to account for the effects of their non-one-dimensionality in a real wake-plasma-wave laser accelerator. These effects include focusing by the radial component of the field of a Langmuir wave, increase of the electron mass as a result of electron oscillations in a transverse high-frequency field, compensation of this increase by a consequently higher effective plasma frequency, and a much faster decrease of the local frequency of the laser radiation on axis in time. In an ultrarelativistic wake-plasma-wave laser accelerator, unlike a weakly relativistic one, the characteristic time of nonlinear pulse distortion with attendant pulse energy dissipation is much shorter than the characteristic time of full acceleration so that a plasma particle has not traveled the entire acceleration length by the time the laser pulse "stagnates" as its frequency falls. This drawback is overridden by the very weak dependence of the parameters of a nonlinear plasma wave on the longitudinal profile of a short laser pulse. Estimates indicate that a laser pulse of 0.3 ns duration and 10^{19} W/cm^2 intensity from a 1 μm radiation source can generate a nonlinear plasma wave with an electric field of about 2 GV/m intensity in a plasma whose density is $n_0 = 10^{15}$ cm^2 and that its field will accelerate injected electrons from an initial energy below 0.5 GeV to an energy of 0.3 TeV over a distance of about 150 m. Figures 3; references 18.

UDC 538.945

High-Temperature Superconductivity of Oxide Systems Including Transition Metals With Degenerate 3d-Electrons

907J0123B Leningrad FIZIKA TVERDOGO TELA in Russian Vol 32 No 6, Jun 90 pp 1629-1636

[Article by R.O. Zaytsev, V.A. Ivanov, and Yu.V Mikhaylova, Institute of Atomic Energy imeni I.V. Kurchatov and Institute of General and Inorganic Chemistry imeni N.S. Kurnakov at USSR Academy of Sciences, Moscow]

[Abstract] Superconductivity of oxide systems including transition metals without appreciable tetragonal distortions of their structure is analyzed theoretically. Models of such oxide systems are being considered $La_{2-x}M_xNiO_4$ series where M denotes an alkaline-earth metal or other element. Assuming equal energy levels $E_a = E_b = E_d$, considering also that evidently the atomic levels a = 3d $(x^2 - y^2)$ and b = 3d $(3z^2 - r^2)$ in La_2NiO_4 are close, the charge of Q of the NiO_2 complex depends on the doping level. Calculations are based on the Hamiltonian which describe strongly correlated p and d excitations which include their Hubbard energy. First is considered superconductivity of laminar oxides with orbital degeneracy of d-electrons into e_g^2 electrons owing to the high-spin state of the Ni^{2+} cation, the lower ground term of the latter being here a two-particle triplet term. On the basis of the n_p—n_d phase diagrams and the kinematic mechanism are then established, the conditions for superconductivity of laminar oxides of transition metals with the structure of a cubic perovskite, its three-dimensional lattice being characterized by a semielliptical density of states $D_0(E) = 2 / \pi(1 - E^2)^{1/2}$. Figures 2; references 24

Phase Composition and Mechanical Physical Properties of $YBa_2Cu_3O_{7-d}$:xHfO_2 Metal-Oxide Superconductor

907J0130A Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 16 No 11, 12 Jun 90 pp 75-80

[Article by V.N. Varyukhin, A.T. Kozakov, S.N. Loboda, and B.A. Panasyuk]

[Abstract] Considering that addition of zinc or hafnium oxide have been found to greatly improve the mechanical properties, including strength and plasticity of the otherwise fragile and brittle high-T_c superconductors of the Y-Ba-Cu-O metal-oxide group, an experimental study of the YBa_2CuO_{7-d}:xHfO_2 (x = 0.3 - 21 wt.%) system was made involving phase analysis, not only mechanical but also electrical tests. Specimens for this study were produced from mixtures of Y_2, $BaCO_3$, and CuO powders in proportions corresponding to a Y:Ba:Cu = 1:2:3 ratio and HfO_2 powder in various amounts. The mixtures were heated to 980°C and held at that in-air temperature for 12 h to ensure complete synthesis. The resulting lumps of the compound material were cooled down to room temperature and comminuted into powder, the latter then being compacted into 2 - 3 mm thick disks 10 mm in diameter for phase analysis and microhardness measurement, or into 20 mm long 4 mm square bars measuring the electrical resistance and determining its temperature dependence. They were sintered at 908°C for 12 h, but in an oxygen atmosphere. Elemental phase analysis was performed under the scanning electron microscope of a Comebax-Micro x-ray spectrum microanalyzer and with an Auger-electron spectrometer for examination analysis of the intergranular boundaries. The data indicate that addition of up to 20 wt.% HfO_2 shifts the superconducting transition temperature slightly downward, from 92 K to 90 K within a 1 - 1.5 K wide range, evidently owing to a lower oxygen index, but increases the microhardness appreciably from below 310 kgf/mm^2 up to 950 kgf/mm^2. With the amount of HfO_2 increased from 03wt.% to 21 wt.%, the fraction of the gray YBa_2Cu_3O phase was found to have decreased from 97.5 wt.% to 32 wt.% while the fraction of the gray Y_2BaCuO_5 phase increased from 0.6 wt.% to 12.6 wt.% and the fraction of the white $HfBaCuO_4$ phase increased from 1.2 wt.% to 28.2 wt.%. The fraction of the dark CuO phase peaked twice, first to 10 wt.% with 4 wt.% HfO_2 and then to 27.2 wt.% with 21 wt.% HfO_2. The improvement of strength and plasticity upon addition of more than x = 15 wt.% HfO_2 may be tentatively attributed not only to the larger volume of the $HfBaCuO_4$ phase but also to its distribution over the matrix. Figures 2; tables 1; references 8.

Effect of Geometrical Surface Irregularities on Readings of Local Work Function by Scanning Tunneling Microscope

907J0130B Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 16 No 11, 12 Jun 90 pp 41-45

[Article by A.O. Golubok and N.A. Tarasov, Institute of Analytical Instruments, USSR Academy of Sciences, Leningrad]

[Abstract] Measurement of the local work function by a combination of two methods, scanning tunneling microscopy and local scanning tunneling spectroscopy, is analyzed for the effect of geometrical surface irregularities on the readings. Inasmuch as current tunneling along surface risers is a rather three-dimensional process, this needs to be taken into account in measurements conventionally based on an exponential dependence of the tunneling current on the distance from tip of the probe to surface of the specimen with empirical pre-exponential factor. The necessary correction is made approximately, on the basis of theoretical calculations, assuming random distributions of atoms over both probe tip and specimen surfaces and a uniform distribution of the potential barrier over the tunneling region. The tunneling Hamiltonian is used for calculation of the tun

neling current and the model of a spherical potential well is used for describing the wave function of atom electrons below the potential barrier. An analytical expression is obtained for the tunnel current which accounts for geometrical as well as spectral characteristics of the specimen surface and covers a broad range of surface irregularities covering large-scale inclusions much larger than the atoms. According to this expression in its simplest version, for very low temperatures and voltages, the image of a surface, which a scanning tunneling spectroscope produces in the form of current isolines and corresponding values of the local work function, is calculated. The results indicate an abrupt change in the work function as geometrical surface irregularities are approached so that their boundaries and dimensions can be determined, which is not possible with a scanning tunneling microscope alone. They also indicate appreciable image distortions by geometrical surface irregularities where the current isolines change, no matter what model has been used for theoretical calculations. Comparing theoretical data with experimental ones is, therefore, a more reliable way to validate a theoretical model than analysis of the image obtained under a scanning tunneling microscope. Figures 2; references 10.

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Topological Quasicharges in Einstein's Theory of Teleparallelism and Combinatorics of Particles

907J0121A Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 33 No 7, Jul 90 pp 15-18

[Article by I. L. Zhogin, Kemerovo State University]

[Abstract] The aim of the study is to demonstrate that for a localized field configuration one can determine an invariant integer quantity, i.e., the topological charge as well as a quasicharge (for configurations with a certain symmetry) which may be interpreted as the presence of a particle. A Riemann space with absolute parallelism whose configuration is defined by a field of reference points is considered; it is shown that for the above localized field configuration, the topological charge or an element of a homotopic group can be determined. It is also shown that with seven reference points, the field theory permits the appearance of diverse combinatorics of particles or quasiparticles which contain both bosons and fermions. Although in the most interesting case there is no topological charge, the quasicharge can be determined for symmetric configurations. An assumption is made that some groups correspond to elementary particles and quasiparticles of the photon, electron, and neutrino type. The resulting combinatorics are compared to those observed experimentally. The absence of a *t*-quark which distinguishes the proposed scheme from the generation combinatorics is specially noted. References 8: 5 Russian, 3 Western.

UDC 517.955

Algebraic Approach to Stability Analysis of Cauchy Problem for Linear Systems of Partial Differential Equations

907J0131B Minsk IZVESTIYA AKADEMII NAUK USSR: SERIYA FIZIKO- MATEMATICHESKIKH NAUK in Russian No 4, Jul-Aug 90 pp 21-27

[Article by S.V. Zhestkov and Ye.A. Yermolayev, Mogilev branch, Institute of Physics, BSSR Academy of Sciences]

[Abstract] The normal linear homogeneous system of partial differential equations $\delta u/\tau$ - gS $C_k(t,x)\delta u/\delta x_k$ (k from 1 to n) = A(t,x) u + f(t,x) (u in R^m space) is considered, stability of its zero solution is of specific concern. The conditions for its stability in the Lyapunov sense are established by selecting from the set of majorant systems of partial differential equations one integrable in closed form. Such a system is found with the aid of a hypercomplex number system D_r formed as the direct product of r = 1,2,... algebras of dual numbers D = D_r with the square of their -i cofactor equal not -1 but 1. Dual numbers of rank r are shown to be applicable to 2^r dimensional systems, whereupon the problem of the majorant system of equations is solved with use of second-rank dual numbers and reduction to a scalar equation. The conditions for stability of the zero solution to the original normal linear system are established in terms of lower bounds for the coefficients in that scalar equation, the lower bound δ being an arbitrarily small fixed number larger than zero. It is always possible, by proper selection of upper bounds, to obtain an m-dimensional majorant system of $2^r \leq m$ equations. The authors thank I.V. Gayshun for discussion. References 8.

Role of Internal α-Particle Structure in Three-Body Problem of dα-Scattering

907J0135E Moscow YADERNAYA FIZIKA in Russian Vol 52 No 2(8), Aug 90 pp 433-446

[Article by Yu.A. Kuperin, Yu.B. Melnikov, and A.K. Motovilov, Leningrad State University]

[Abstract] Scattering of a deuteron by a He nucleus is analyzed as a three-body problem also involving an α particle more precisely than has been done before, namely by not treating the α-particle as one without structure. For the purpose of evaluating and including the role of its structure, energy-dependent model potentials are formulated according to the method of extended Hilbert spaces which will represent the analytic and asymptotic properties of the interaction operators. The effective three particle equations thus reduce to a system of Faddeyev equations for the system components and boundary-value problems uniquely solvable in special asymptotic classes of functions. It thus becomes possible to calculate the effects of $^5Li_{gs}$ and $^6Li_{(1+)}$ as well as $^5He_{gs}$ resonances on asymptotic dα-decay. A triangular representation is obtained by treating the dα-system as one of six spinless particles, formulating its total Hamiltonian in the Hilbert space $L_2(R^{15})$, extracting the effective Nα-interactions, deriving from the Schroedinger equation a matrix equation for the "vector coefficient" of triangular expansion, this equation representing an infinite system of coupled equations, and then reducing this system to a finite one by the Feshbach method of projection onto open channels. A model representation of energy-dependent interactions is obtained in two steps, replacement of the original interaction operator W_z with another one consisting of two operators $W_\beta(z)$ (β = 1,2) corresponding to paired pα and nα subsystems. Next, a four-channel Hamiltonian is constructed whose B_{01} and B_{02} operators representing respective elastic scattering reactions are fitted. Following an analysis of this Hamiltonian, the boundary-value problem for the wave function of the $\alpha + d \rightarrow + \alpha + n + p$ process is solved taking into account all those three resonance channels. The authors thank A.A. Kvitsinskiy, K.A. Makarov, S.P. Merkulyev, and S.L. Yakovlev for helpful discussions. Figures 3; references 19.

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